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# 3D

DECEMBER 1999

SPECIAL REPORT

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TUTORIAL

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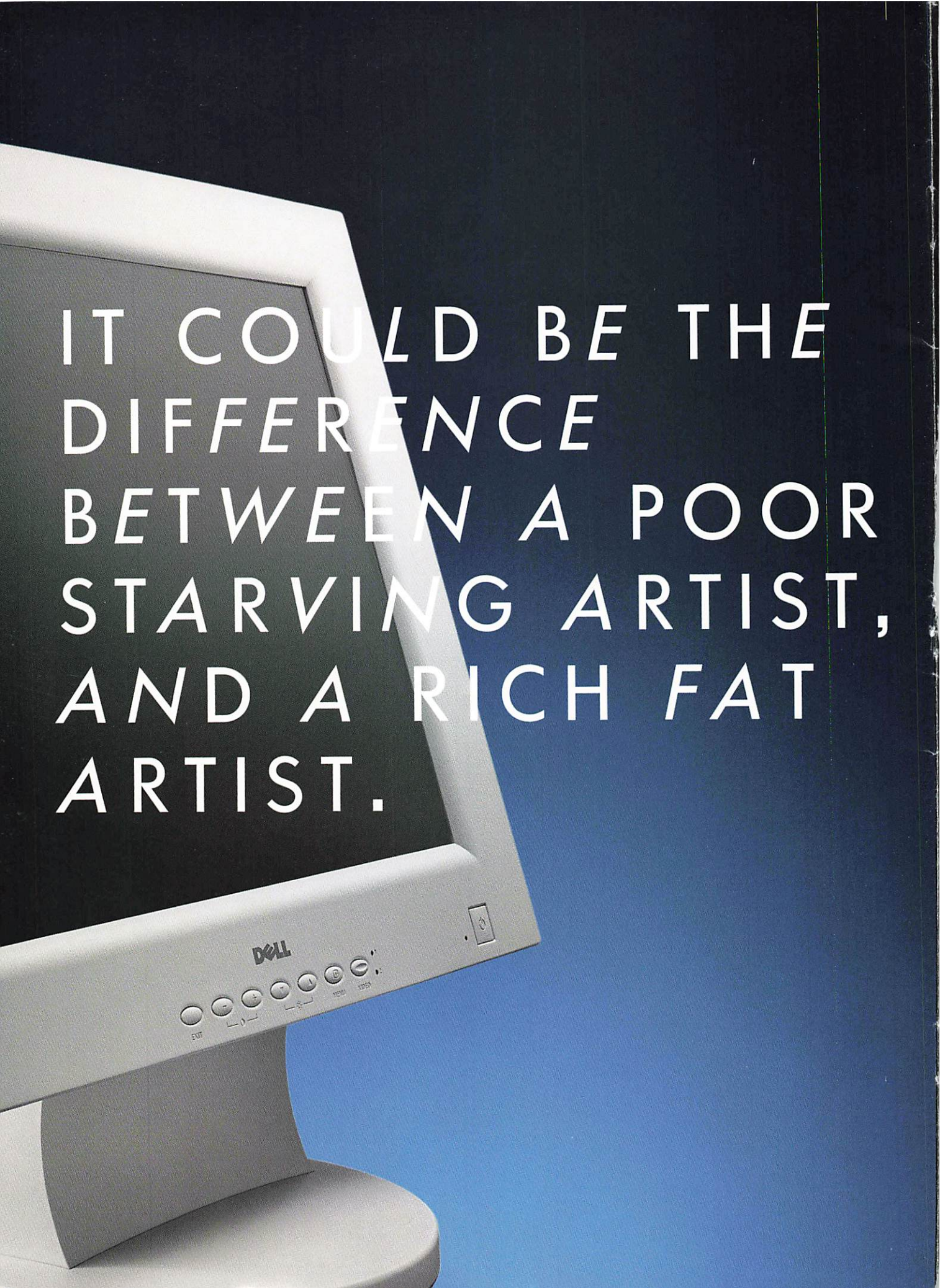
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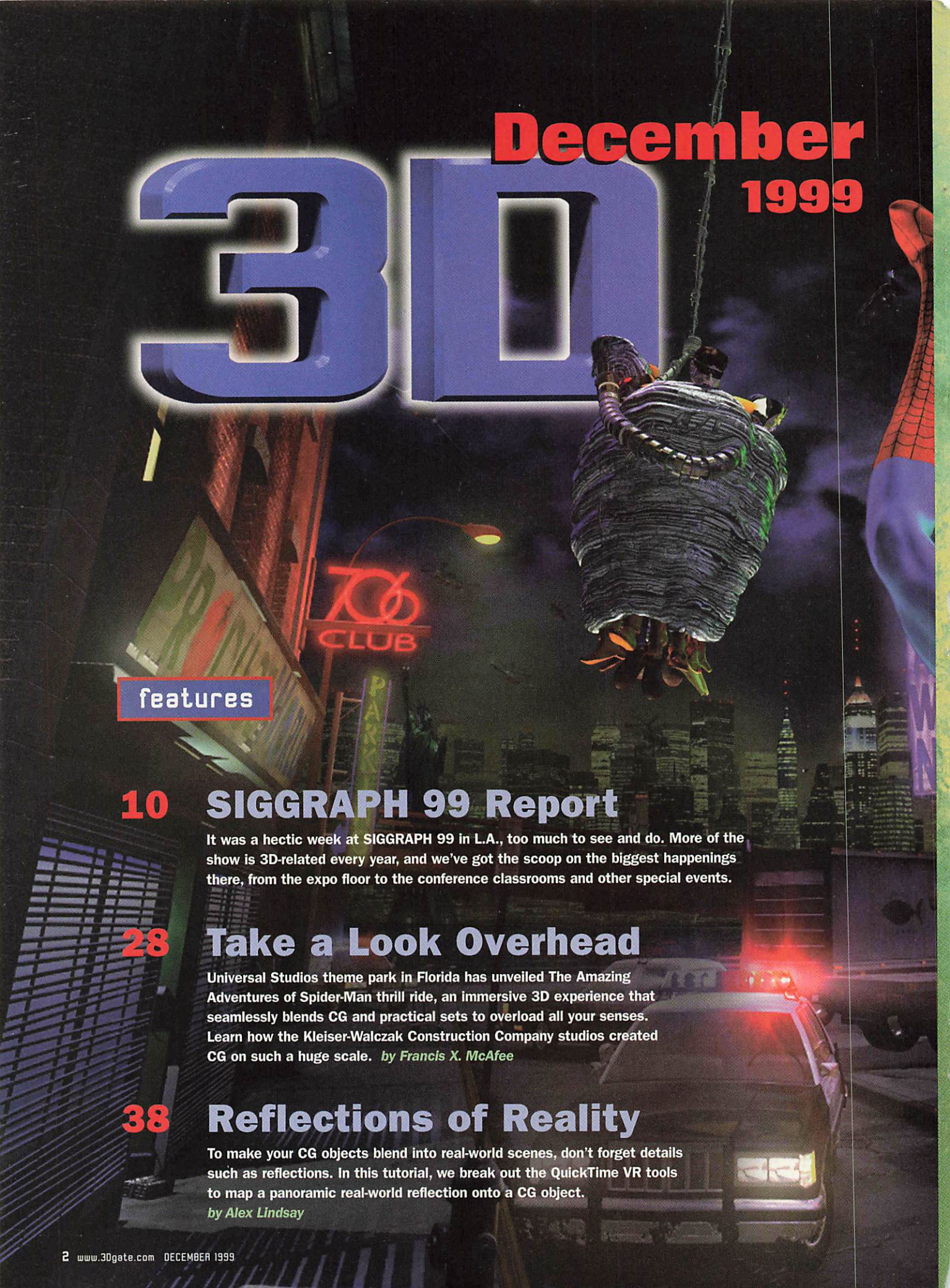


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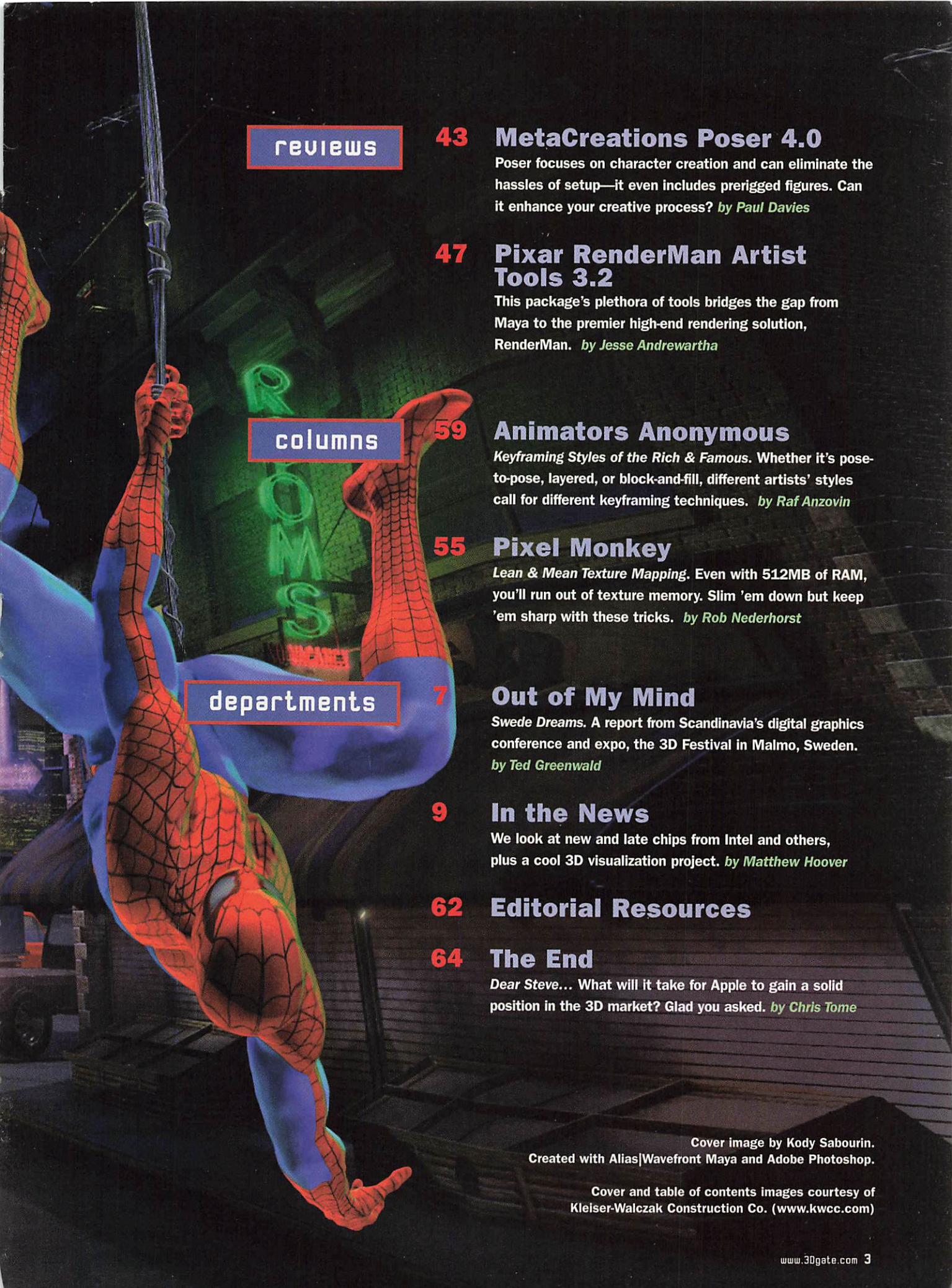

## reviews



## columns



## departments



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Created with Alias|Wavefront Maya and Adobe Photoshop.

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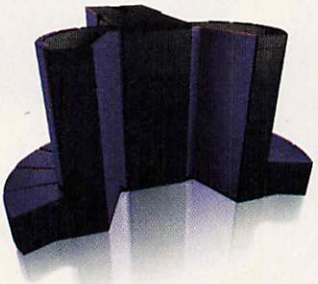
# Forget megahertz.
# We're talking gigaflops.

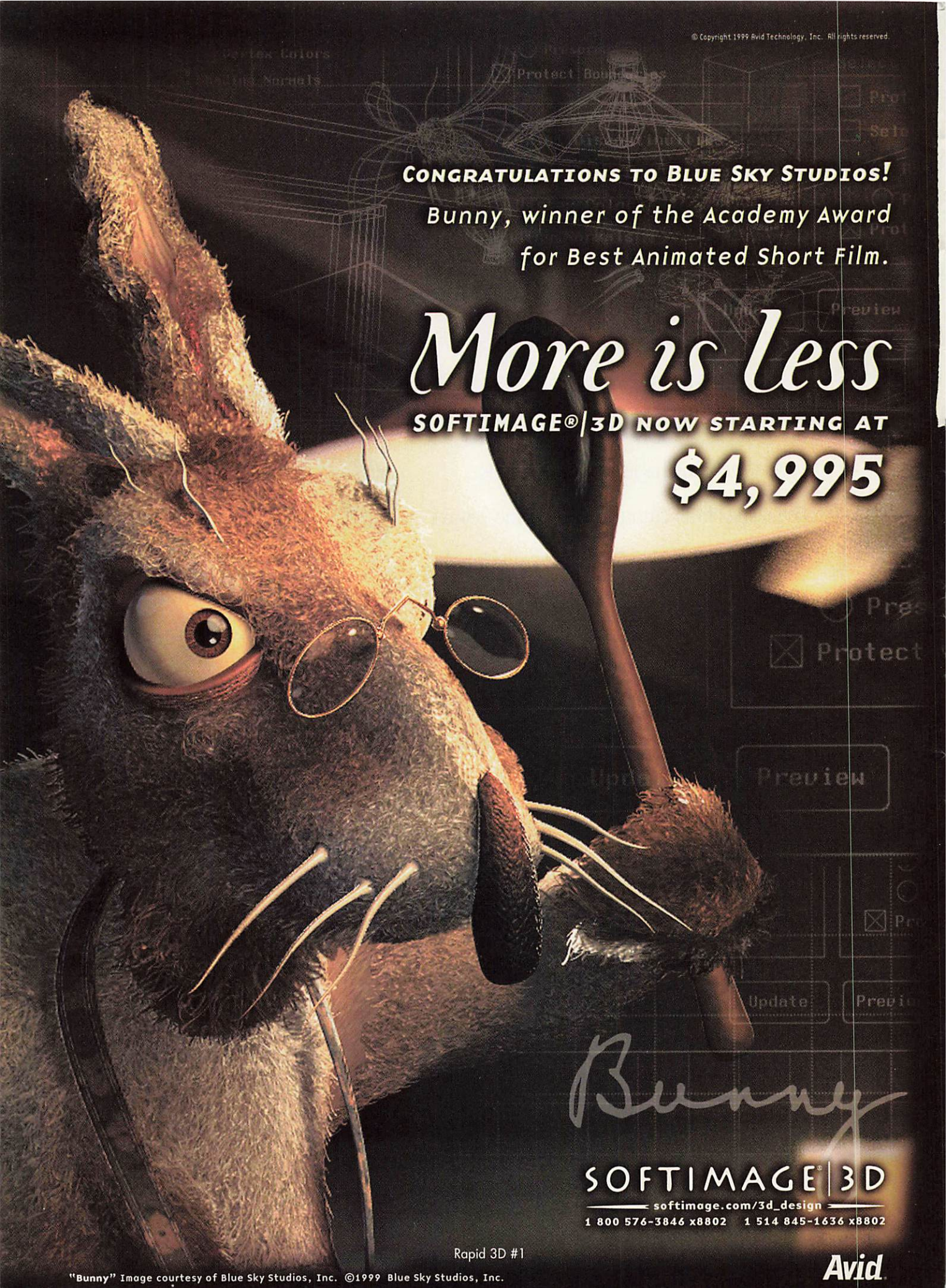
## Presenting the Power Mac G4. The world's first desktop supercomputer.

What makes a supercomputer "super" is its ability to execute at least one billion floating-point operations per second. It is a staggering measure of speed known as a "gigaflop." The new Power Mac™ G4 is the first personal computer in the world to achieve this level of performance. The secret of this stunning speed is the new G4 processor with its Velocity Engine™ – the heart of a supercomputer miniaturized onto a sliver of silicon. Applications that tap the Velocity Engine's power typically run twice as fast as they do on the fastest Pentium III-based PCs.* Common Photoshop tasks, for example, run twice as fast. And using a set of Intel's own tests, the 450MHz G4 chip was 2.65 times as fast as the 600MHz Pentium III processor. Chances are, you've never even heard of a gigaflop before. But very soon you won't be able to live without at least one on your desk. For more information and complete specifications, visit us at www.apple.com. Think different.™



*What makes a supercomputer "super" is its ability to execute at least one billion floating-point operations per second. Like the new Power Mac G4.*


*The G4 chip incorporates the Velocity Engine – the heart of a supercomputer miniaturized onto a sliver of silicon.*




Rapid 3D #1

"Bunny" Image courtesy of Blue Sky Studios, Inc. ©1999 Blue Sky Studios, Inc.

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# Swede Dreams

Pop quiz: What country leads the world in cel phones, desktop computers, and Internet bandwidth per capita? Here's a hint. It's a place where mass-market penetration of digital communications meets a tradition of fine industrial design, making fertile ground for future developments in 3D graphics.

The answer is Sweden. There, amid the cobblestone streets and copper spires of the town of Malmö, the 3D Festival took place during October 6–8, presenting a heady mix of inspirational presentations, panel discussions, and technology demos. The Festival's priorities, according to organizer Jimmy Hassel, were to avoid the bland environs of traditional convention centers, to create a social atmosphere that would draw the notoriously taciturn Scandinavians out of their Nordic shells, and to energize their work with inspiration drawn from the international art, film, architecture, and engineering communities. As far as I could see (through admittedly jet-lagged eyes), the event succeeded on all counts.

Despite the exotic venue—a converted 19th century slaughterhouse known as the Slagthuset—the scene was surprisingly familiar. To my great amazement (and relief), all sessions were conducted in letter-perfect English. The show floor was populated with European arms of Softimage, Discreet, E&S, Intergraph, Compaq, and the like. Presenters included CG heroes such as ILM's Sean Schur, Blue Sky's Chris Wedge, Disney's Isaac Kerlow, LionHead's Peter Molyneux, and Dave Sidley, 1998 winner of the *3D* magazine Big Kahuna contest—plus European luminaries such as Toni Meca, who showed models of unfinished architectural masterworks of Antoni Gaudí.

Clad in black, strikingly blond and blue-eyed, the attendees were far younger than the average denizen of the 3D Conference & Expo, say, or SIGGRAPH. In Scandinavia, CG is a young industry, and I would venture to guess that most of the attendees were students.

Master sculptor Dan Platt's presentation of his transition from fashioning toy action figures by hand to modeling them in 3D was a highlight. Later, Platt joined Isaac Kerlow, photographer Åke Nordgren, and Anders Rönnblom, publisher of the Swedish magazine *EFX Art & Design*, in a fascinating panel entitled "How Can We Refine the Digital Image?" Nordgren described his early experiences with Scitex's Giclée printing process that has produced digital printouts of sufficient quality to hang in prestigious galleries throughout Europe.

Sweden now has an opportunity to build a graphics industry that combines the cultural heritage of Europe with the technological heritage of Silicon Valley. Although the 3D community is very small there, dramatic growth might be closer than you'd expect. The last person I met before running for the ferry to Copenhagen for my flight home was Jonas Birgersson of Bredbandsbolaget, a Swedish ISP. Sweden, Birgersson said, achieved its leadership in cellular telephony due to its unique regulatory flexibility and lack of pre-existing infrastructure, along with a sophisticated consumer market and a free economy. Now, for the same reasons, the country is on the brink of an explosion in Internet bandwidth. Bredbandsbolaget is working to install Ethernet access in millions of apartments throughout the country. Having accomplished this goal, the nation would be in a position to develop pioneering broadband services to be sold throughout the world as bandwidth issues are solved elsewhere.

Near the top of the list of broadband beneficiaries, of course, is 3D. In fact, one of the most promising companies in Internet 3D is Cycore, which hails from—you guessed it. It appears that we all may be hearing more about Sweden before long.

Ted Greenwald

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BY MATTHEW HOOVER

# Keeping Up with the Rambuses

**Intel misses its mark for the 820 chipset, while MuSE & HP track airplanes in real-time 3D.**

In the lightning-fast world of computer graphics hardware, any product delay has some people sounding a company's death knell. It's not usually that bad—who in this industry believes release dates anyway? But delays certainly cause companies' plans to change. At SIGGRAPH 99, most workstation vendors were showing off their Pentium III machines but had nothing revolutionary to display. "In development" described most folks' next-generation boxes, which translates to "Intel's still working on the chip." And they still are.

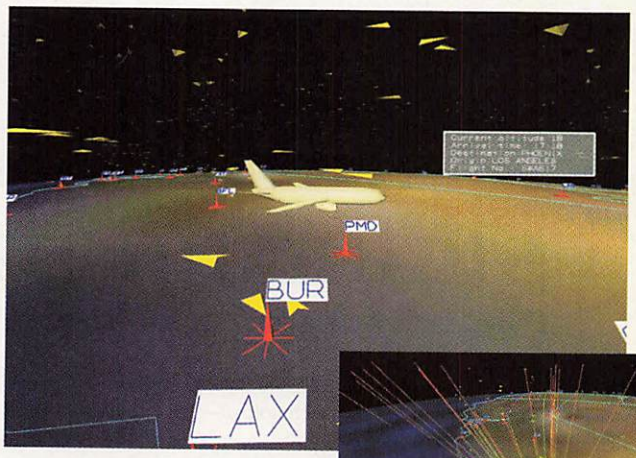
Intel's 820 chipset, code-named Camino and developed in conjunction with Rambus Inc., was slated for fall delivery but in late September was embarrassingly delayed. The new chip is designed to increase bus speed between the CPU and memory subsystems. The 820 is based on a hub architecture with a central Memory Controller Hub that talks to the CPU via the host bus, the graphics subsystem through the AGP bus, and the RAM through Rambus. The I/O Controller Hub handles other tasks and is linked to the Memory Controller Hub. And thanks to the Memory Translator Hub, you can use either SDRAM DIMMs (up to 1GB) or RDRAM SRIMMs (up to 1.5GB), but not both. Got it so far?

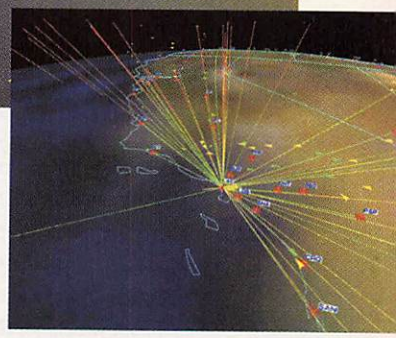
Apparently, the 820 wouldn't work on motherboards with three memory slots. (The original Rambus spec covered four slots—perhaps the memory problem was known and Intel hoped cutting back to three slots would eliminate it?) Empty slots need continuity modules under this architecture, because Rambus uses memory in a daisy-chain fashion. The Rambus design is supposed to equal electrical superiority, but if it ain't a product yet it can't be superior.

After the missed ship date, Rambus Inc. sent out a press release, stating essentially that workstation vendors are still behind them on this, even if they're behind. The delay will likely hurt sales for Dell, HP, Compaq, and others who have committed to the 820.

## Patent Wonder

One of the most mysterious companies in Silicon Valley, Transmeta, showed a bit of its hand with U.S. Patent Office number 5,958,061: "... a microprocessor which is faster than microprocessors of the prior art, capable of running all of the software for all the operating systems which may be run by a large number of families of prior art microprocessors, yet is less expensive..." Short version: it's the long-rumored "x86-killer," which is intended to be faster than anything ever built and capable of running anyone's OS or software. Quite a claim, and Transmeta apparently intends to do this through simplified chip design. The chip will comprise a "morph host," the hardware processing part, and "code morphing software," a software emulating part, according to the company; the two work together as a processor. Simple hardware, high clock speeds, on-chip software speed enhancements, and a translation buffer; it could add up to a killer, but so far it's only a patent.



**(Top) A single aircraft in the LAX airport corridor, as displayed on the MuSE system. Clicking on an aircraft's icon brings up relevant data. At right, a user has selected to view all inbound LAX traffic.**

## MuSE & HP Track Airplanes in 3D

At the annual Air Traffic Controllers Association gathering in San Diego in September, MuSE Technologies and Hewlett Packard showed off their joint project, a real-time 3D visualization system for tracking airplanes.

The demo air traffic monitoring system features zoomable, panable 3D graphics—a big improvement over traditional "top-down" air-traffic displays—that lets air-traffic managers better understand flight activity, congestion, and weather impact. Fifteen types of data (location, velocity, precipitation, and so on) were used in the project, and the data is displayable by any of the 15 dimensions. Multiple traffic controllers can access the system at once and share different views with other users. The demo system combines MuSE's perceptual computing software and by HP's newest Visualize workstations, which can project on large displays or multiple monitors. Large displays and effective graphical representations of data allow users to visualize information and reach conclusions faster, which is crucial in understanding the complex relationships among weather, traffic, and other factors.

**Matthew Hoover is managing editor and news editor for *3D*. Email him at mhoover@mfi.com.**

# SIGGRAPH 99:

## Bigger, faster, and more 3D

Just a short flight from Silicon Valley—Northern California's high-tech hotbed—lies Southern California's Silicone Valley, its own special kind of hotbed, defined by swimming pools, movie stars, and (every other year) the computer graphics industry's premier trade show.

Now entering its 27th year, SIGGRAPH (the Special Interest Group on Computer Graphics of ACM, the Association for Computing Machinery) continues to dazzle and educate attendees and exhibitors alike while keeping pace with the evolving needs of its industry. Schmooze factor notwithstanding, SIGGRAPH has a lot to offer 3D professionals, with regular increases in 3D-related offerings for both the conference and exhibit sectors. This year's show was no exception.

Although a few thousand attendees and a couple dozen vendors short of 1997's record-breaking turnout, SIGGRAPH's return to L.A. this year saw some impressive advancements in products and technology, along with a sizeable crop of first-time exhibitors. Additionally, away from the glamour and glitz of the expansive show floor was the other side of SIGGRAPH—one where shared information, practical techniques, and in-depth discussion defined an educational and often collaborative environment focused on CG.

We sent a slew of reporters into the darkest recesses of the show to capture the sights, the sounds—even the smells of SIGGRAPH 99. Their assignment: to focus on software, hardware, capture (of both motion and form), video, and storage. But SIGGRAPH is more than products, so we've included highlights of the conference and special events that shaped the show experience. The result is a high-res snapshot of the current state of computer graphics and a testament to the vitality of the art and science of 3D.

# 3D Software: No dog & pony show

**by Ben de Leeuw**

Scattered amongst the cyber-corporate dog and pony shows at this year's SIGGRAPH were some interesting products, some new technologies, and a few interesting industry-wide trends. The first and perhaps most promising trend in 3D software was productivity streamlining. It seems that everyone in the biz has suddenly realized that even a great tool is only as good as its interface. Booth after booth loudly declared new customizable interfaces.

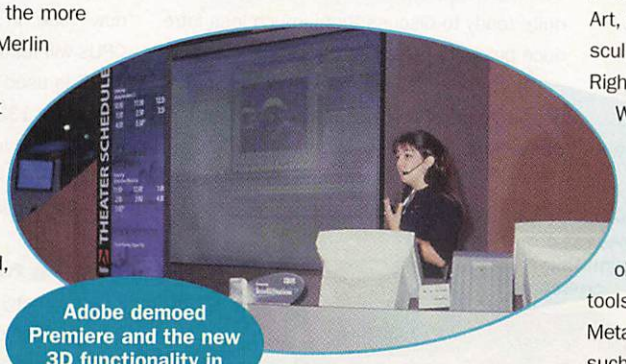
**Enhanced Productivity** Discreet showed a fully customizable interface for 3D Studio MAX 3.0, along with external referencing for better group production management. Alias|Wavefront showed similar capabilities for Maya 2.5, and Avid followed suit, including a customizable interface in their long-awaited (and still in beta) Sumatra—the next generation of Softimage 3D. Even smaller players like Caligari (trueSpace) and Hash (Animation:Master) were making sure that their users could work the way they want to.

Another productivity enhancement that made it onto everybody's feature list this year was enhanced real-time interactivity. Maya, MAX, Sumatra, and NewTek LightWave 6.0 all proclaimed better real-time interactivity for better workflow. The heavy hitters were joined by Canadian company Digital Immersion, which introduced Merlin VR, a mid-level animation package being marketed on the basis of superfast, full-featured real-time rendering. It captured the attention of game designers as a quick previz tool; the more robust but still DirectX-powered Merlin 3D is on the horizon. The most impressive real-time rendering at the show was Cycore's web-based Cult3D. Now with full export capability from MAX 3.0, Cult3D allows you to put Phong-shaded, reflection-mapped, transparent objects on the web in real time.

One widespread feature that will delight animators is nonlinear animation. Previously available in only a handful of packages, such as Nichimen N-World and Side Effects Houdini, this year it hit the big time. Nonlinear animation is similar to nonlinear video editing, found in products such as Adobe Premiere. Blocks of animation can be moved, sequenced, overlapped, and blended, letting you reuse animation and create new sequences without having to re-animate. Maya, MAX, and Sumatra all added this feature, and Nichimen showed off a newer and better version in their latest package, Mirai.

Perhaps the most interesting development in nonlinear animation was the announcement of the upcoming Orchestrate3D from start-up Improv Technologies. Orchestrate3D is a stand-alone package with routes in and out of all the major animation packages. It combines nonlinear animation with behaviors and goal-oriented execution through a hierarchical finite state machine. This means you can have objects and characters that animate autonomously based on reactions to what's going on around them. This will let desktop animators create the kind of crowd dynamics seen in recent feature films like *Antz*, or in interactive characters such as Leon, the live interactive host of this year's Electronic Theater, created by animator Mitch Butler using Improv's software.

**Character Animation** Visual effects house Station X Studios introduced Messiah, a high-end character animation tool that works stand-alone and as a plug-in to LightWave. Originally created as a proprietary tool, Messiah's feature set includes IK and FK, bones, real-time interactivity, and procedural/keyframe animation blending. The Alpha/Intel version should be shipping by the time you read this, with a Mac version not far behind. This is character animation software created by programmers who are also animators.




Adobe demoed Premiere and the new 3D functionality in After Effects.

On the subject of characters, some facial animation tools made a noteworthy showing. Famous Technologies demonstrated Famous Faces 1.5, their tool for working with facial motion capture data. Another stand-alone package with pipes into MAX, Maya, LightWave, and Softimage, Famous' software lets you import a model, define the areas controlled by the facial markers, and paint in a fall-off region for each marker. By painting overlapping regions, you can create very convincing blended animations. Tools are also included for adding exaggeration and keyframing on top of the motion capture.

Another interesting facial tool is TalkSync, from Visual-Voice Inc., which automates the tedious process of character lip-sync. A user-defined series of phoneme shapes automatically synchronize a character's mouth with the audio. Automatic lip-sync is not new—it's already available in packages like Magpie Pro from Third Wish. What's new is the approach used by TalkSync. Most speech recognition uses a word database to figure out what the speaker's saying. This is good for dictation but not so great for animation because it often misses the subtlety of how different speakers pronounce words. TalkSync uses an acoustical database, which means the program listens to the sounds you make, not the words you say, allowing you to accurately lip-sync any speaker in any language, even gibberish.

**3D Paint Tools** 3D painting was another hot ticket this year. Interactive Effects showed the latest version of Amazon 3D Paint 3.0, their high-end 3D paint package for SGI, but they had several rivals yapping at their heels. Flesh 2.0 from Digits 'n Art, also SGI-based, offered modeling and sculpting additions to their paint program. Right Hemisphere showed Deep Paint 3D for Windows NT/95/98, a synthesis of their Deep Paint Photoshop plug-in and their old 3D paint package, 4D Paint. Though still in beta, Deep Paint 3D looked very cool. It lets you paint 3D objects in real time using natural-media tools that match or surpass those found in MetaCreations Painter 3D package. Media such as oil paint can be faithfully reproduced including the depth and shininess of the paint itself.

Pixologic showed its flagship product, ZBrush, a 2D painting tool for 3D painting. ZBrush allows traditional artists to put 3D-rendered qualities in 2D images. ZBrush stores depth information and updates in real

time as you adjust surface attributes like color, texture, and lighting.

On a slightly different path was Maya Paint Effects from Alias|Wavefront. A new feature included in the basic Maya Complete 2.5 package, Paint Effects is a system for painting procedural nongeometric 3D elements into your scene. You can quickly paint splines into the scene that provide the basis for trees, grass, lightning, or even hair. These elements can interact with all scene elements, geometry, lights, and so on, but are not themselves geometry.

A similar though less extensive product is Shag:Hair from Digimation, purveyors of the ubiquitous MAX plug-ins. Shag:Hair is an impressive plug-in that creates moving, realistic hair as a render effect.

For geometric modeling, FreeForm from SensAble is a super-cool combination of software and hardware that lets you sculpt virtual clay with a haptic pen. Using force feedback to let you feel the shape and texture of the clay, FreeForm creates a highly intuitive modeling paradigm that combines CG and traditional sculpting.

**Easy on the Pocketbook** Lowering the cost of animation production was another selling point for many products. For production companies seeking lower total workstation costs, new operating system support was one of the answers. Linux ports were the favorite migration, with Maya and Sumatra offering Linux-based rendering and Mirai releasing a full Linux version.

For desktop animators, production costs mostly reflect the price of their modeling and animation software, so the cheaper the better. For modeling, Play Amorphium, a metaclay-style organic modeler, came in at $129, and Nichimen is porting Nendo, their low-cost ($99), high-powered modeler, to Macintosh and BeOS. Hash Inc. drew large crowds to see version 7.1 of Animation:Master, their full-featured character animation package. Though no new features were introduced at SIGGRAPH, at $199, Animation:Master is still far and away the best low-cost animation solution available.

Even better than cheap might be free. Blender, developed by Dutch coder Ton Roosendaal and released by Not a Number, is a free full-featured animation package you can download over the Net (www.blender.nl). Available for almost every OS (Mac's not ready yet), Blender is a remarkably adept animation package that has garnered such grassroots support that two users from Japan wrote a Japanese manual. Takeo Igarashi's Teddy, free at www.alice.org, is a really cool sketch-based modeler easy enough for kids to use. By drawing simple shapes, you can extrude, inflate, and create surprisingly recognizable models. Teddy is included with Alice, a simple 3D interactive construction kit you can use to make games and such from Teddy models. Both are free and quick to download.

**Grab Bag** On the game front, Alias|Wavefront showed Maya Builder, a special version aimed at game developers, including a full API, polygon tools, texture tools, and keyframing tools. Dynamics, interactive rendering, and paint effects are not included. Finally, in the 3D to 2D category, Digimation demonstrated Illustrate! 4.0, a cartoon renderer plug-in for MAX. Though Illustrate! is only in the middle of the pack as cel renderers go, an impressive new feature was the ability to convert cel-rendered 3D into 2D Flash animation, making the third D optional.

All in all, not a bad showing for the Big Sig. With big points scored in productivity streamlining, the bar for 3D software functionality continues to rise at a steady pace while prices continue to drop. No wonder those dogs and ponies get so excited.

**Ben de Leeuw is creative director at infoplasm, a San Francisco-based animation studio (www.infoplasm.com). He teaches in several Bay Area animation programs and wrote the book *Digital Cinematography* (Morgan Kaufmann, 1997).**

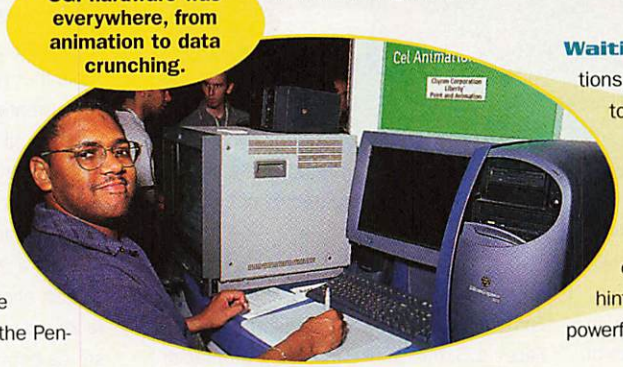
# Hardware: Fast, but playing the waiting game

**by J.V. Bolkan**

Demonstrating the importance of machine-over-software, the coveted entryway booths (the first thing you see when entering the show floor) were filled with massive SGI and Intel displays. Perhaps providing evidence as to where the money is in 3D, workstation vendors dominated this year's show floor with oversized booths bustling with demos, testimonials, and flashy multimedia productions created using their hardware.

Ironically, given the prominence of the workstation vendors, they didn't generate significant buzz during the show. The reason for the relative shortage of new releases was simply a matter of timing. Intel (whose booth was little more than an enormous shrine to the Pentium III Xeon processor) has a new generation of CPUs on the horizon, but they weren't quite ready to discuss them, much less introduce products based on the new chips.

Intel's embargo, spurred by delays in the development of its Coppermine core version of the Pentium III, left the various workstation vendors with no choice but to tout existing products and make vague promises as to how they'll exploit "the future CPUs we can't discuss now" (see "In the News," p. 9). The new CPUs will feature 0.18-micron technology (0.25 is used in current Pentium IIIs) and will support a 133MHz bus with the 820 chipset. The technology will also support clock speeds in excess of 600MHz, with 750MHz versions likely by the end of the year.



**SGI hardware was everywhere, from animation to data crunching.**

**Waiting for Intel** Despite the restrictions, Intergraph came as close as possible to a major platform announcement. The company draped purple shrouds over the systems in their booth the first day of the show, unveiling the new ZX1 ViZual Workstations at a press conference that evening. With plenty of hinting about the potential for "new and powerful" CPUs on the horizon combined with

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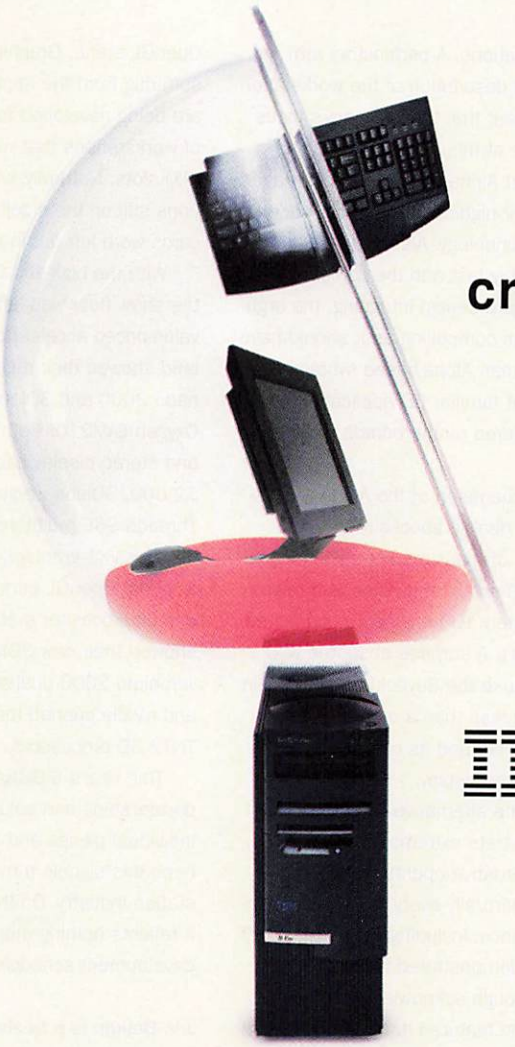

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## the keynote & awards

Anthony DeRose, Ph.D.—whose groundbreaking work in surface subdivision may revolutionize computer graphics by adding a third subdivision primitive to the familiar polygons and patches—was granted the ACM SIGGRAPH 99 Computer Graphics Achievement award. A giant in his field and a kind man of slight stature, DeRose vainly tried to belittle his achievement by claiming he was but one team member and credit belongs to all of those who helped him. He was choked with emotion when he thanked his wife, mother of their four-month-old, for 16 years of support and sacrifice.

Next up was Jim Blinn, Ph.D., a living legend and recipient of many major awards. He became the only two-time SIGGRAPH Society award winner, receiving the biannual Steven Coons Award. Blinn developed surface texturing, bump mapping, and collaborated on reflection mapping. His entertaining presentation walked us through some of the highlights of his life and career starting with his first experiences on an all but forgotten PDP9 computer, stashed in a lab at school. He recalled sitting at a desk, struggling with textures to represent electrons orbiting atoms, when he looked down at his leather shoes and saw the light of the sun modifying the texture of the leather by casting shadows. What sprang from this observation was bump mapping.

The Keynote presenter was Professor Helaman Ferguson, mathematician and sculptor. Famous for his sculptures that are physical manifestations of mathematical equations, he fascinated the audience with Klein bottles, hyperbolic discs, negative Gaussian curves, anecdotes, and samples of his work. At Breckenridge, he entered a snow sculpture contest. His huge structure had walls that were just four inches thick. Not only did it survive a class of school kids crawling through it, but a subsequent heat spell demonstrating the strength of mathematical sculpture. His full-sized multi-ton sculptures grace many campuses around the world. He designed a unique computer-supported stone-carving system to allow him to precisely locate each point of a 3D representation of an equation and carve his way into the stone. This system gives him the power of replication and scaling. He closed with his own version of a keynote—banging two of his bronzes together, which, like tuning forks, emitted room-filling sound.

*—Karl Stocker*

details on Intergraph's new Wahoo architecture, the basic configuration of the unveiled ZX1 was barely mentioned. The ZX1 is powered by dual 600MHz Pentium III Xeons and comes with the company's Wildcat OpenGL 3D accelerator. Other than a striking new stylish black case, the unveiled system, lacking both the new CPU and Wahoo, wasn't earth-shattering news.

Of much more immediate importance to the 3D community was Intergraph's announcement that Intense3D (making its first appearance at SIGGRAPH), its new graphics card division, will be able to sell products such as the Intense3D Wildcat 4110 to other vendors. Previously, Intergraph has offered its premium OpenGL accelerators only as options in its own workstation line, selling slightly lower-performance cards to other vendors under OEM agreements and in the retail channel.

Although Dell didn't show new systems on the floor, they did have a prototype of their next-generation Intel-based workstation hidden in the briefing room. Again, Dell was unable to discuss the CPU at the heart of the system, but they were more than happy to talk about the new Rambus technology that will leverage the power and high clock speed of the anticipated processors.

**Partners & Platforms** With new systems pretty much under wraps, most workstation vendors emphasized their strategic partnerships. BOXX Technologies unveiled an HDTV editing and compositing system, the FusionBOXX HD, built around eyeon Software's Digital Fusion HD. Dell was showing a system with Pinnacle's DC-1000 video capture card. The HP, IBM, and Intergraph booths all advertised software products from companies such as Avid/Softimage, Discreet, NewTek, and others at least as heavily as they promoted their own hardware.

In SGI's mammoth display area, the company's various IRIX workstations and 320 and 540 Windows NT-based systems were randomly dispersed, with the focus on application areas rather than platform type.

Even with the opening provided by the lack of Intel news at SIGGRAPH, Sun Microsystems and Alpha Processor Inc. failed to capitalize in the workstation arena. When asked what they were showing in the way of 3D workstations, the booth personnel launched into demonstrations of various networked visualization programs and distance imaging applications. A perfunctory arm wave and brief description of the workstation line made it clear that the company's focus was elsewhere at this show.

The folks at Alpha were more than eager to discuss their high-performing, but underselling CPU technology. Although the Alpha chip is certifiably fast and the company's new motherboard design intriguing, the argument wasn't as compelling as it should have been. Rather than Alpha-based systems blazing away at familiar 3D applications, the booth featured motherboards mounted on a wall.

Compaq, champion of the Alpha processor, may have dealt a knockout punch to Alpha's hopes of mass-market acceptance by killing its NT-on-Alpha division and releasing approximately 100 engineers connected with the project. A surprise absentee was Apple, who chose the Seybold conference in San Francisco less than a month later to unveil the new G4 and its companion 22-inch LCD CinemaDisplay.

Although the alternative CPU vendors didn't demonstrate extreme strength, Linux, the latest alternative operating system, did—sort of. Virtually every workstation vendor in attendance, including Alpha, made reference to or demonstrated Linux on their systems. Although acknowledging Linux, virtually no one featured it. Most demonstrations ran on Windows NT or, in the case of Sun and SGI, Solaris and IRIX, respectively.

**In the Cards** Intel was again responsible for an extreme lack of new product announcements in the high-performance OpenGL arena. Graphics card vendors were suffering from the ripple effect. New cards are being developed for the next generation of workstations that will feature AGP Pro (4X) slots. Naturally, with the new workstations still on the sidelines, the graphics cards were left out in the cold.

With the high-end OpenGL market quiet, the show floor was left to the mid-range and value-priced accelerators. Evans & Sutherland showed their recently introduced Tornado 3000 and 3Dlabs promoted their new Oxygen GVX210. Both feature dual-monitor and stereo display capabilities for less than $2,000. 3Dlabs weighed in with the PowerThreads SSE multithreaded OpenGL drivers for their VX1 graphics board, which promise to boost OpenGL performance significantly in multiprocessor systems. Appian Graphics showed their new 3Dlabs Permedia 3-based Jeronimo 2000 dual-screen OpenGL card, and nVidia pushed their cost-effective Riva TNT2 3D processors.

This year's SIGGRAPH was more about partnerships and solutions rather than the individual pieces and building blocks. Perhaps this signals a maturation of the workstation industry. On the other hand, perhaps it reflects nothing more than Intel's product development schedule.

**J.V. Bolkan is a freelance multimedia creator and consultant based in Springfield, OR. He's been writing for various computer publications since 1988 and specializes in OpenGL cards, professional monitors, and 3D workstation evaluations. He can be reached at jvbolkan@aol.com.**

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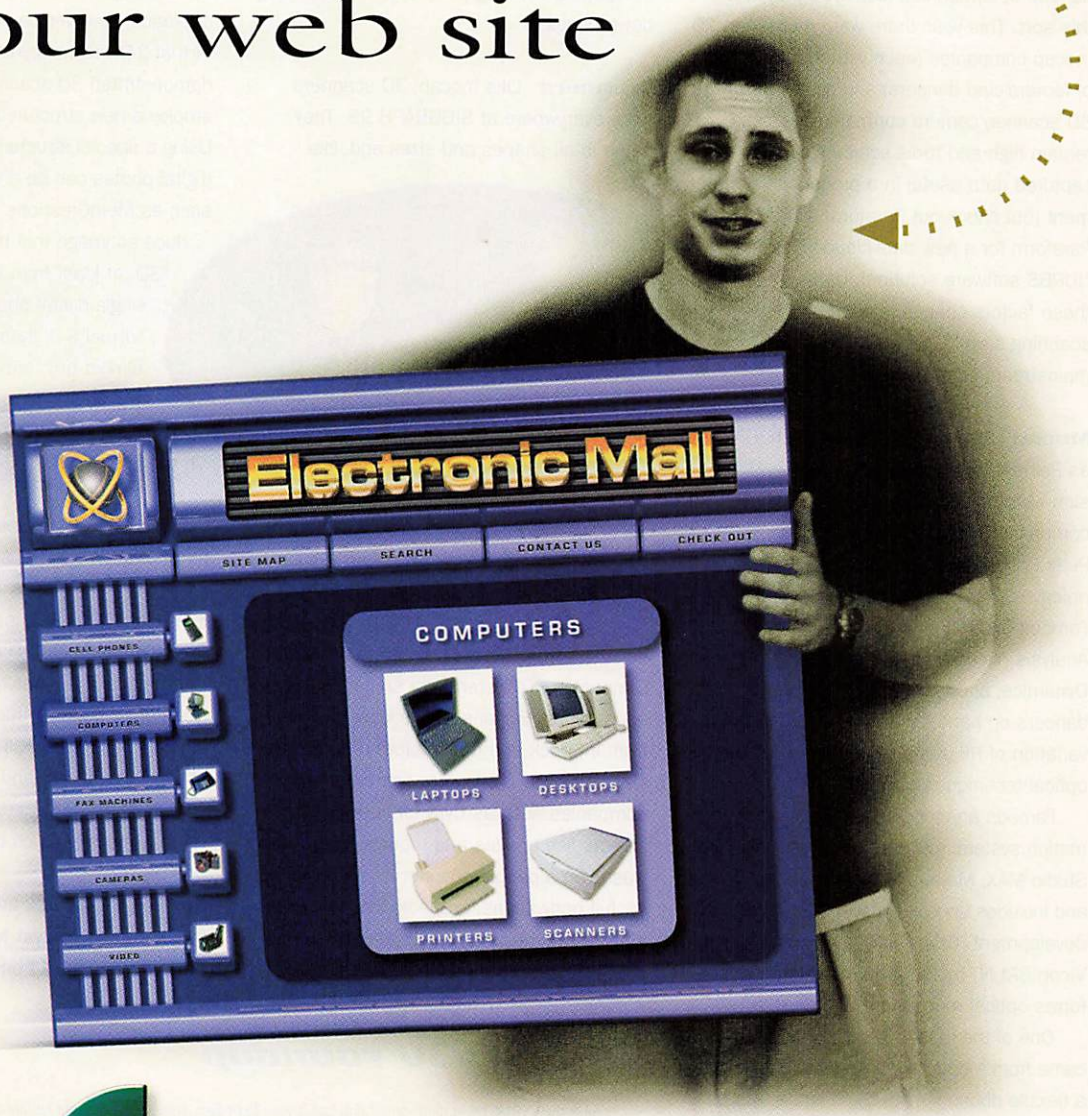


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## SIGGRAPH 99

# Mocap & 3D Scanners: Capturing noses & buildings

**by Guy Wright**

Just counting dancers and 3D noses, SIGGRAPH 99 was the year of motion capture and 3D scanners. Two years ago, only a handful of companies displayed products of this sort. This year, there were more than 20 mocap companies (each with its own troupe of leotard-clad dancers) and over a dozen 3D scanner/camera companies. Prices remain high and tools scarce for making captured data useful in a production environment (but check out Paraform 1.0 from Paraform for a new data-cloud-to-NURBS software solution). Until these factors change, mocap and scanning aren't likely to crack mainstream 3D studios.

**Mocap** Along with veterans such as Polhemus and Ascension were up-and-coming companies such as Peak Performance Technologies, Puppet Works, Famous Technologies, Motion Analysis, Vicon Motion Systems, Charnwood Dynamics, and a host of others. With dancers on hand, all of them used some variation of RF (radio frequency), wired, or optical techniques to capture data.

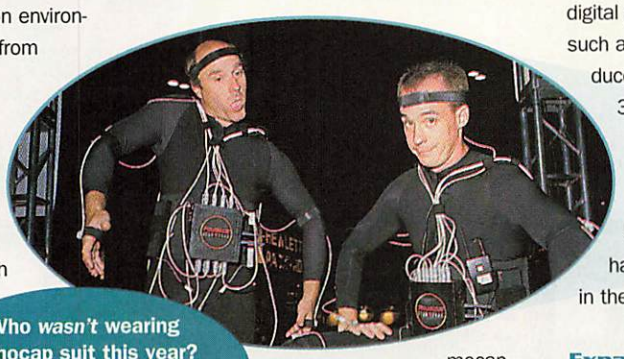
Famous announced that their facial animation system now supports Softimage, 3D Studio MAX, Maya, and LightWave file formats and includes special export features for game development. Other highlights included the Vicon 8Rt NT-based system, which now performs optical mocap in real time.

One of the most off-beat mocap devices came from Measurand, maker of Shape Tape, a flexible ribbon sensor that can be twisted or bent while it feeds data to a computer. ID8 Media dazzled the show floor with the Gypsy II motion capture suit, a self-contained mocap outfit straight out of a cyborg fashion show. The suit can either transmit mocap data in real time via cable or optional wireless transmitter, or store it in a fanny-pack device.

A few mocap management and manipulation software companies exhibited, such as DreamTeam Limited and Kaydara (who seemed to have copies of their FiLMBOX system in just about everyone's booth), and companies such as Pepper's Ghost and Credo Interactive promoted their motion libraries, motion-editing tools, and custom mocap services.

Even though prices for mocap systems are coming down a bit, the technologies still aren't cheap, ranging from about $25,000 to $500,000. The increase in the number of companies entering the market should bring down prices.

**Scanners** Like mocap, 3D scanners were everywhere at SIGGRAPH 99. They came in all shapes and sizes and, like mocap systems, were fairly expensive (roughly ranging from $10,000 to $500,000). There were scanners from Digibotics, CamSys, and Dimension 3D-Systems for small objects spun on lazy Susans. There were scanners from InSpeck and Real3D for human head-sized objects. There were scanners from companies such as Cyra for very large objects like bridges and mountains. There was even a people scanner from Cyberware for full body scans. InSpeck previewed version 3.0 of their software, which converts chaotic captured mesh into NURBS using a predefined patch structure, making output much better suited to animation.



**Who *wasn't* wearing a mocap suit this year? Polhemus was riding this wave years ago. Now new vendors are, too.**

Most of the scanners used lasers, some used multiple digital photographs, and some used multiple cameras. The most interesting approach, however, came from Minolta and Virtual 3-D Technologies. Both companies demonstrated 3D scanner/cameras that employ a new structured light technique. Using a special structured light flash device, digital photos can be analyzed by software such as MetaCreations' MetaFlash to produce an image that behaves as though it's 3D (at least from the front) based on a single digital photograph. According to Virtual 3-D, these devices can use almost any form of light from radio frequencies to radar, and the company has plans for a 3D radar-based version in the near future.

**Expanding Horizons** Mocap character animation and 3D scanning are on the rise, but many studios are finding only limited uses for the technology and still prefer to rely on good old 3D artists and animators to do most of the hard work. Bottom line: Don't worry folks—your 3D modeling and animation gigs are still secure long enough, at least, for artists and animators to take control of these powerful tools and add the value of human touch to their output.

**Guy Wright is editor-in-chief of *Multimedia Week* and an analyst for Jon Peddie Associates (a division of Penton Media).**

## the web3D roundup

You'd think VRML never died—or if it did, that it went to heaven. Nearly 2,000 of the faithful converged upon Hall B of the Los Angeles Convention Center for an online 3D extravaganza dubbed the Web3D RoundUP. Over the course of three hours, producer Timothy Childs presented 32 demos of online games (Groove Alliance, Absolute Software, Abe Megahed's Hypercosm), ecommerce showcases (Superscape), virtual talk show hosts (Pulse Entertainment's rendition of Jay Leno), graphical chat rooms (Electronic Café's "Roadside Attractions"), authoring tools (Cycore, Cybelius, Shout3D), and everything else you might imagine ("Real Life Pranks Through VR" by Survival Research Labs).

Onlookers were encouraged to applaud by twirling whizzles, which created a sound not unlike that of a duck in heat, and to signal dismay by upending can-of-moo noisemakers, all courtesy of web-3D pioneer blaxxun. Tension ran high as the demo artists scrambled to present their work within strict time limits of three minutes or less. The front row was supplied with toy air guns and instructions to silence demos that went overtime in a hail of ping-pong balls. It was, as Childs put it, "an exercise in chaos management."

Chaos is inevitable at this stage of the web's evolution, but the Web3D RoundUP suggested that it might burst forth in three dimensions sooner than most observers recognize. Time will be required for the market at large to sort out the amazing number of technological and conceptual choices on display. Meanwhile, see them for yourself at www.web3droundup.org.

*—Ted Greenwald*

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## SIGGRAPH 99

# Video Hardware & Software: Thriving in the Z dimension

**by Kimberly Reed**

From a video perspective, SIGGRAPH 99 was less of a "Wow!" show and more of a "Duh!" show. As in, "Duh—why didn't we think of that earlier?" Behind all of the glossy pamphlets and lip-glossed booth babes, the technology that really shone was reflected by the products that make our professional lives easier, our production pathways smoother, and our renders faster. In many ways, this year's show was about the convergence of video and 3D.

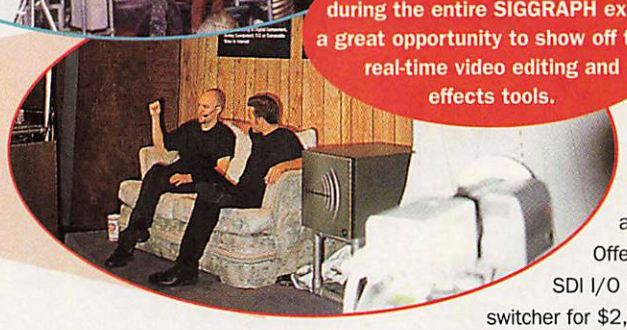
Although these worlds are converging, it's still early enough that each company has its own idea about what convergence means. Some of the big video companies are developing partnerships with 3D software developers, such as Quantel and Alias, while others like Avid/Softimage and Discreet are enhancing their own 3D technology. Companies such as DPS are utilizing 3D plug-ins, while others such as Adobe are concentrating on their ability to output 3D file formats.

A couple of trends were evident, such as 3D extraction and camera tracking (which you can read more about on *3D*'s web site at www.3dgate.com), but most of the major video players are taking various and sundry approaches to incorporating 3D.

Adobe pushed their venerable After Effects further with closed-door demos of version 4.1. In addition to rendering improvements and added features, Adobe acknowledged that their users are quite interested in 3D. Hence, 4.1 adds support for Softimage PIC and Discreet RLA 3D file formats. Production Bundle owners will get the 3D Channel Pack, which integrates 3D elements into 2D comps while still maintaining info about Z depth, surface normals, textures, background colors, and object and material ID. AE 4.1 also adds crucial effects that operate in 3D, like depth matte, depth-of-field blur, ID matte, 3D fog, and 3D channel extract. The full Production Bundle is $1,499, and the Standard version is $699. Upgrades from version 4.0 (both Standard and Production) are $49.95.

**video on the web** For additional SIGGRAPH video coverage, visit www.3dgate.com

The most visible result of the Avid/Softimage merger was a really cool booth.

**Play Inc. was on the air during the entire SIGGRAPH expo, a great opportunity to show off their real-time video editing and effects tools.**

Although much of the booth buzz was about the long-awaited Sumatra (see "3D Software: No Dog & Pony Show," p. 11), video announcements were interesting too, but they didn't come from the Avid side as you might expect. Avid announced the beta of Softimage DS 3.0, which elegantly combines Softimage's 3D expertise and with Avid's nonlinear editing (NLE) legacy. Expected by the end of the year, the new 3D-ready nonlinear editor will support unlimited layers, multiple light sources, true depth of field, and displacement mapping. Other welcome additions include compositing of multiple resolutions in a single sequence, editing enhancements including "swift menus," an effects tree, and enhanced titling borrowed from Avid's Marquee.

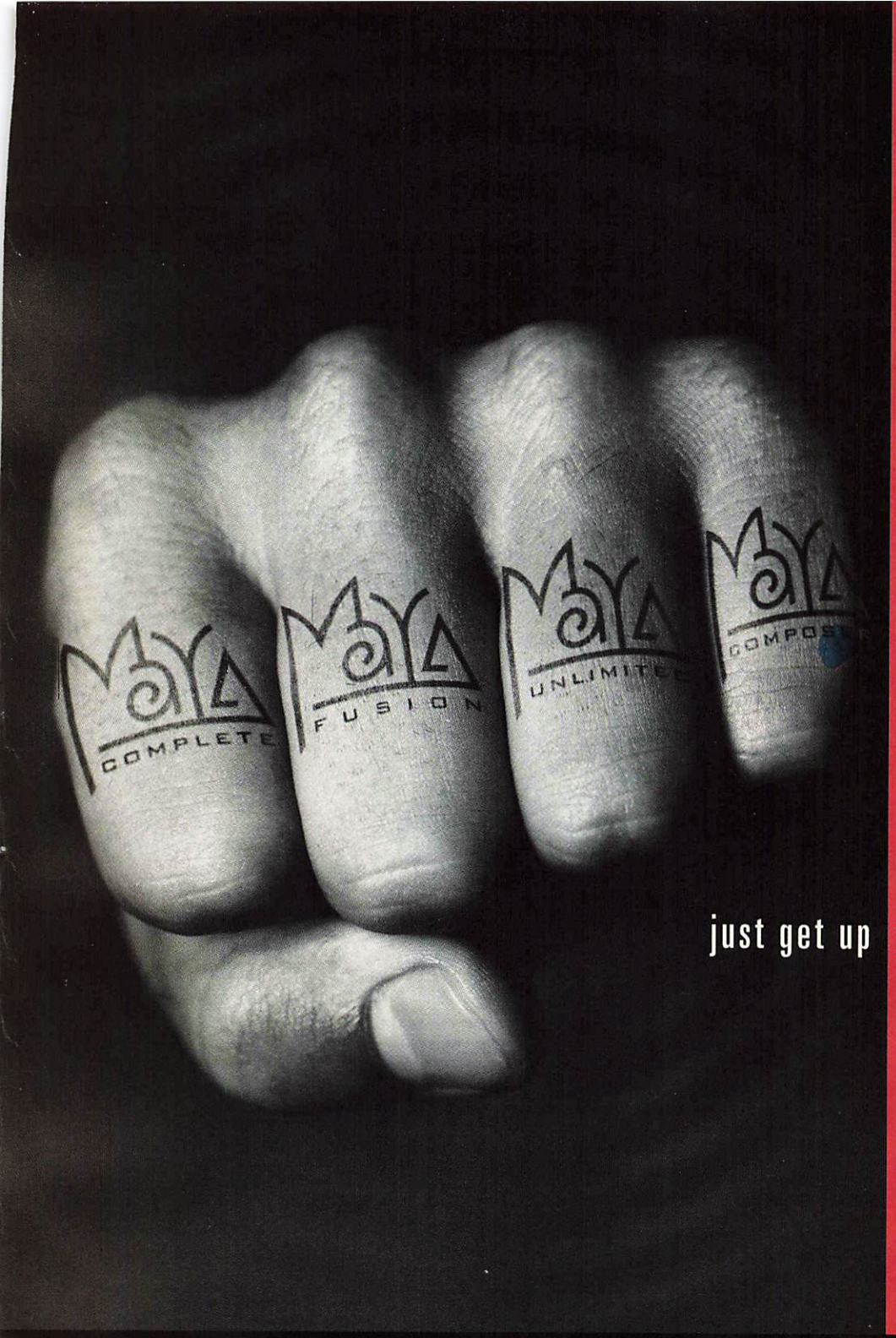
OK, here's one "Wow!" Despite all of the changes within Discreet due to SGI's move toward Intel-based workstations and away from MIPS as well as their SIGGRAPH announcement to support Linux over NT and IRIX, Discreet managed to crank out a couple big updates to serious products, announcing delivery of fire* 3.5 and inferno* 3.5. These updates enable real-time HDTV I/O with the SGI HD I/O board, which means that the Discreet family of products can now offer real-time online editing, effects, and I/O in all DTV/HDTV formats.

With their background in video hardware, DPS understands the integration of video and 3D as well as anyone. The PVR (Perception Video Recorder) has been a part of animation production pathways for years, but it looks like that pathway will smooth out. LockStep, announced at the show, allows you to remain within Discreet 3D Studio MAX 3.0 while controlling PVR, PAR NT, Hollywood, and Perception RT/RT3DX systems.

One of the first companies to consider 3D a natural extension of video was NewTek. Nine years after the Video Toaster, NewTek's big video announcement at SIGGRAPH 99 was Toaster NT, a bold resurrection of the egalitarian ideal to bring video and 3D to the masses. Offering an uncompressed SDI I/O board with a 16-channel switcher for $2,995, Toaster NT even includes in-sync Speed Razor SE editing software and LightWave VT (a lite version). NewTek claims the Toaster is the first uncompressed D1 tool to combine video and 3D (albeit by data sharing via common file formats) below $100,000; even if math ain't your strong suit, $2,995 is way lower than this. And in case sales tax isn't your strong suit, the new Toaster costs less than the California sales tax for Softimage DS.

Play's Electric Image Universe 3D Animation System will be of interest to 3D folks doing video of all kinds. Universe provides for tight integration between Electric Image and the Trinity desktop production system to allow 3D scenes to be combined with live video sources in real time. Play also announced what many were expecting in the first version of Trinity: Trinity NLE. This amps up Trinity's Preditor NLE component to deliver color correction, luma and linear keying, and manipulation of the aforementioned Universe data—all in real time.

Known for their innovations in the television production process, Quantel has been making high-end systems for broadcast graphics, titles, and effects since 1973. Their products, however, were black-box systems containing proprietary hardware and software, making media interchange quite difficult. But Quantel has opened their

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doors, and the first 3D package through is Alias|Wavefront Maya. Quantel announced that they will OEM Maya Unlimited for implementation on its Open Render Engine Technology—basically an NT box networked to Quantel systems to assist in rendering. Maya on Quantel is set to ship as an option December 1999, for around $10,000. For the first time, a standard (shrink-wrapped) 3D tool can be used alongside Quantel's systems in a network.

**Happy Together** The video world is learning to accommodate 3D, and vice versa. Driven by the special effects industry, many fascinating technologies are becoming available to mix live-action video with a bit of the rendered trip fantastic. Hold on, because if you thought that shot in *The Matrix* was trippy, you ain't seen nothing yet.

**Kimberly Reed is technical editor for *Digital Video* magazine, *3D*'s sister publication. You can contact her at kim@dv.com.**

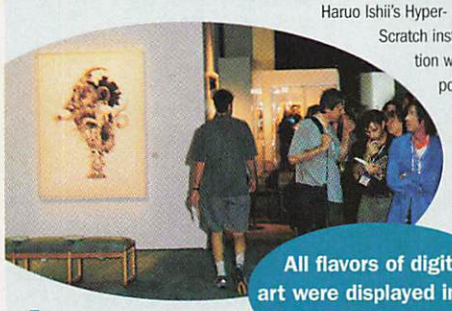
## the technOasis

The technOasis art gallery was truly a refreshing spot, located in a quiet corner of the Convention Center, far removed from the hubbub of the main show floor. The liquid-like projections on the floor gave the main room a mellow, meditative vibe, which was further enhanced by the four or five twentysomethings crashed out on beanbag chairs in front of a large projection screen showing short 3D animations. Some of the shorts, such as "Zhen Po," an animated mass of swirling colors and textures generated from a 2D seismic wave field simulation, created a decidedly psychedelic atmosphere.

I was impressed by innovative print works displayed on the walls, such as Anna Ullrich's "Assumption of Pleasure," which contrasted turn-of-the-century black and white imagery with computer-generated objects and textures, and Kenneth Huff's series of works making elegant use of procedural and static textures and colors. There were also several more "traditional" works like photo collages and busy abstract pieces with interweaving patterns, objects, and textures.

The installations were the highlight of the exhibit, including the Fisherman's Cafe, an exercise in nonverbal communication facilitated by overhead camera sensors and tabletop projections; CrossTalk, a two-person keyboard that sent users' input to a projection screen; and Tracking the Net, where users moved around in a virtual space by manually manipulating a cube of netting in front of a projection screen. Haruo Ishii's HyperScratch installation was very popular; it allowed users to manipulate lights and sounds in a 3D space by using simple hand motions, which were captured by cameras and are interpreted as location information by the HyperScratch Controller. The signals were converted to MIDI signals that activated motors and light bulbs attached to a frame of copper pipes in front of the participant.

**Interactive art was successful at fostering interaction among people.**



**All flavors of digital art were displayed in the technOasis.**

The Composition On a Table room contained four tables with sliding boards, turntables, buttons and knobs on their otherwise bare white surfaces. Overhead cameras projected interactive games onto the tables to create a mixed-reality environment that responded to input from the participants in real time. Every few minutes, the projected games would change, repurposing the tables' interfaces to suit a new interactive task. The games included various mazes and a musical interface that allowed participants to generate bell-like sounds by pressing buttons. All of the games allowed multiple participants to interact with the installations and with each other to create audio/visual art.

Also worthy of mention was Steve Gompf's "Televisors" installation, which blurred the lines between reality and fiction. Gompf's fictitious historical framework in which he positioned televisors as "rare, often quaint, mechanical televisions produced between 1884 and 1928," caused quite a bit of confusion among attendees. The display comprised several televisor units made of old photographic and audio equipment and some random bits of junk, through which Gompf presented digital animations of Eadweard Muybridge's late nineteenth-century motion studies.

*—Michael Kobrin*

**It's not a disco, it's the Emerging Technologies exhibit.**

## the millennium motel

Millennium Motel. The name capitalizes on the ubiquitous "millennium buzz" that has permeated our culture since the beginning of the year, and also rates a high coolness factor. But more important, as the chosen theme for this year's Emerging Technologies venue, it may be even more prophetic than SIGGRAPH's organizers intended. Billed as "an interactive journey into the future," the Millennium Motel was a clandestine meeting place for scientists and artists to gather and mingle in an intimate setting, without raising the eyebrows of the desk clerk.

Visitors to this hands-on environment were encouraged to explore, experience, and experiment with a broad range of installations created by innovative students, educators, artists, and scientists from all walks of digital life. Interactive projects had attendees viewing, creating, and navigating 3D worlds, objects, and characters through virtual space.

Serving as a digital hostess for the venue was Digital Marlene, an animated 3D clone of the late actress Marlene Dietrich, displayed on monitors close to the entrance. Unveiled by Virtual Celebrity Productions at the Millennium Motel, Digital Marlene was created using facial motion capture technology (www.virtualceleb.com).

The "metaField Maze" by Bill Keays is a digital version of the familiar game where users manipulate knobs with their hands to control a marble rolling on a movable, flat surface. This larger-than-life version was projected on the floor, and participants moved the virtual "board" by activating sensors underneath the carpet with the placement of their feet (www.media.mit.edu/~keays).

Visitors to Steven Schkolne's "Surface Drawing" project created and manipulated intricate, organic 3D shapes by moving their hands through space (www.cs.caltech.edu/~ss/sdraw). A little further into the Motel, guests sporting 3D goggles journeyed through Agueda Sim's "Microworlds, Sirens, and Argonauts," virtual, multi-scale, microscopic worlds that grow and transform as users interact with them (simo@felix.usc.edu).

Musically inclined attendees conducted a complex electronic orchestra using hand and baton movements picked up by video cameras, at Jakub Segen's "Visual Conductor." The system detected rhythmic beats and gestures to control tempo and volume (segen@lucent.com).

No interactive digital motel is complete without collaboration. Wearing lightweight, head-mounted displays, visitors to "Shared Space: Collaborative Augmented Reality" created interactive art with other users, both remote and face-to-face, using virtual animated characters and props in a tabletop environment (www.hitl.washington.edu/share).

Emerging Technologies is one of the most dynamic and provocative venues at SIGGRAPH, and this year's Millennium Motel was no exception. Desk clerk or not, this is a must-do experience. The theme for Emerging Technologies 2000 is Point of Departure (a.k.a., "The POD"). For additional information on SIGGRAPH 2000 (July 23-28, New Orleans, LA), visit www.siggraph.org/s2000. For more details on the Millennium Motel, check out www.siggraph.org/s99. See you in The POD.

*—Gretchen J. Bay*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Rapid 3D #7

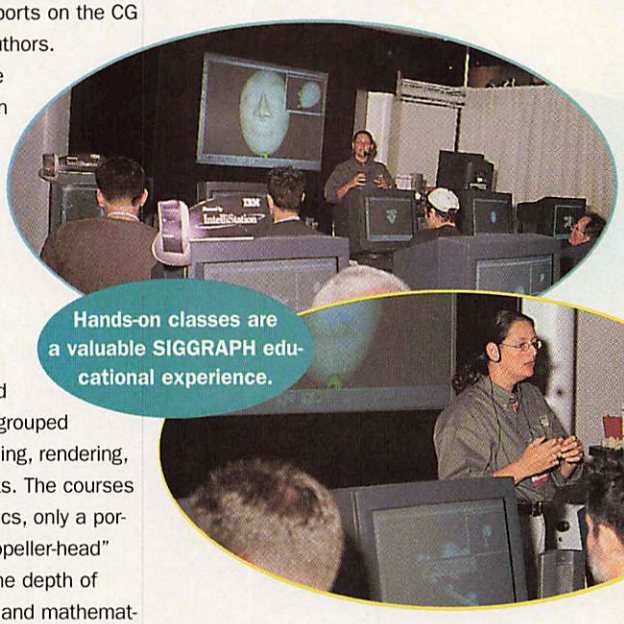
# Conference Sessions: Not just for propeller-heads

**by Pat Johnson**

Although your friendly neighborhood sales rep might tell you otherwise, SIGGRAPH is more than a noisy, bustling show floor, exploding with the latest and greatest products and technologies. There's another side where the emphasis is on education, rather than merchandise, and attendees can interact with their peers while garnering knowledge and skills.

SIGGRAPH 99's conference side consisted of three main educational areas: Courses, where the focus was on the development of professional skills in a classroom environment; Panels, where industry experts sparked discussion and provided insight; and Papers, jury-selected reports on the CG industry presented by the authors. While past conferences have been heavily concentrated on science and mathematics of digital technology, this year's show saw a serious increase in sessions relating to 3D techniques, with direct application to entertainment.

Most of the 40-plus courses, 50-plus panels, and accompanying papers were grouped into basic categories: modeling, rendering, texturing, lighting, and effects. The courses covered a wide range of topics, only a portion of which required a "propeller-head" background. Nonetheless, the depth of exploration into the science and mathematics of each area was similar to years past. This year's SIGGRAPH offered a glimpse of the pure research that underlies what end users experience as the bells and whistles of new, fully developed software.



Hands-on classes are a valuable SIGGRAPH educational experience.

**The Sessions** The conference explored a broad and sometimes opposing range of techniques. In the area of rendering, for example, courses such as "Non-Photorealistic Rendering" were complemented by courses like "Image-Based Modeling, Rendering, and Lighting," which focused on deriving realism from photographic sources. Papers also looked at "Image-Based Rendering" as well as "Imaginative Rendering." Modeling techniques for creating everything from free-form shapes to morphable 3D faces were explored from all points of view, with an emphasis on the appropriate application of each.

Balanced against these investigations was the highly popular, hands-on, full-day course at the Creative Applications Lab. This course introduced 3D concepts through high-end animation software, developed and taught for the third time by Michael O'Rourke. Another departure from research-based presentations were sessions on the practical aspects of animation and film production. The panel "3D Tracking in FX Production: Blurring the Line Between the Virtual and the Real" offered insight into the hair-raising aspects of compositing live-action with digital effects. Veterans from Rhythm & Hues Studios, ILM, Digital Domain, Geometrix, and Hammerhead Productions gave a lively presentation supported by real-life horror stories and detailed visual examples.

Another particularly enjoyable presentation was Pixar's look at texture and light in their panel "The Making of *A Bug's Life*," in which they discussed how they visualized the ground-level realm of an insect.

Several presentations explored the art and science of utilizing light and texture information captured from photographic sources to create believable 3D environments. One stunning example was presented by the University of California at Berkeley Computer Science Division, lead by Paul Debevec, who delighted audiences at SIGGRAPH 98 with his digitally rendered footage of the Berkeley Campanile Tower. This year's work, *Fiat Lux*, was set in St. Peter's Basilica and provided the opening animation in the Computer Animation Festival's Electronic Theater. This astonishing piece of rendering was complemented by U.C. Berkeley's panel "Recovering Reflectance Models of Real Scenes from Photographs." This panel addressed transforming visual experiences into applicable computations for extremely accurate digital environments.

According to Debevec, "This technique is significant because computer graphics is being increasingly used to visualize real objects and environments. Applications in entertainment and other fields often require that aspects of the real world be rendered realistically from novel viewpoints and/or under novel illumination. One might want to realistically render a film location in different lighting and add in digital props and characters with the expectation that the rendered results would be the same as what would have happened had it all been for real."

Debevec's methods, derived from a sparse set of photographic sources, resulted in a lighting-independent model of the scene's geometry and reflectance properties that can be rendered with arbitrary modifications via traditional rendering methods. To fully appreciate the practical application of this research, you need only to see the breathtaking views presented in *Fiat Lux* (http://fiatlux.berkeley.edu).

Many other presentations contributed to the remarkable offerings of SIGGRAPH's 1999 Courses, Papers, and Panels (for a complete listing, check out www.siggraph.org/s99/). The ever-evolving world of computer graphics allows the conference to continually embrace and explore the science, mathematics, and art of digital technology—for propeller-heads and artists alike.

**Pat Johnson is co-director of the Graduate Computer Arts program at the Academy of Art College in San Francisco, CA. She is acting education director for the San Francisco chapter of SIGGRAPH. You can reach Pat via email at patjoh@aol.com.**

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SIGGRAPH 99

# Storage: Like SANs through the hourglass...

**by Walt Bransford**

Performance, reliability, scalability, and service defined the storage sector at this year's show, along with the increasingly heavy demands placed by the computer graphics industry. The cross-platform, multi-format, networked environment common to most CG production is setting the pace for storage providers, whose products are evolving to meet these demands in the face of challenges such as platform compatibility, hardware and software support, and user sophistication. Fast, high-capacity solutions for low- and mid-range shops are becoming more affordable and easier to use. Meanwhile, the demands of video file serving are pushing advances in delivery technologies that will hopefully disseminate throughout the industry.

SIGGRAPH 99 was peppered with an array of storage offerings ranging from tried-and-true components to high-end solutions offering advanced capacity and performance. Of nearly 20 storage companies exhibiting, including veterans Ciprico, BOXX, Medea, and nStor, were a few SIGGRAPH first-timers such as System Upgrade Inc., Consensys, and MetaStor. These fledgling vendors are further evidence of the growing importance of storage systems to high-end graphics professionals.

**Storage Speed** The was a lot of buzz on the show floor about SAN (storage area network) products. SANs are fast RAID devices with a Fibre Channel or 1GB Ethernet connection that enables multiple network users to treat it like a local drive. Some SANs include software that allows users to work on or view the same files simultaneously. The main feature that separates SANs from other storage products is speed, with products at the high end delivering transfer rates of at least 100MB/sec.

Representing the high end were companies such as Ciprico and DataDirect Networks. Other SAN solutions were presented by nStor, Intergraph, Storage Concepts, MetaStor, and System Upgrade. With a few exceptions, SAN prices typically range from $50,000 to $250,000.

**Storage Options** HDTV, video, and digital movies bring staggering challenges to the graphics community. Post Impressions Inc. displayed their SpiDDR digital disk recorder (DDR), designed for just such chal-

## the studio (1.0)

Making its official debut at SIGGRAPH 99, The Studio (formerly known as the Guerilla Gallery) was a smashing success. Although open only to Conference Select attendees and above, The Studio offered visitors a wide range of output devices, large-format giclée printers, and 3D rapid prototyping machines.

Utilizing more than 110 computers—a mix of PowerMac G3s, iMacs, Octanes, O2s, and NT workstations from Intergraph, SGI, and HP—The Studio allowed artists to bring their digital files and create works on canvas, watercolor paper, photo paper, and more, using high-end printers from Epson, ColorSpan, Xerox/Splash, and others. Free T-shirts (donated by *3D* magazine) and Wyndstone transfer papers had people making custom art they could wear. 3D rapid prototyping systems from Z-Corp, Sanders, and 3D Systems were also present, letting 3D artists make their virtual models a physical reality. A Cyberware scanner enabled visitors to walk away with 3D versions of their noggins.

Over 200 3D models were prototyped and close to 1,000 prints were made, all at no extra cost to qualified attendees. Pete Braccio, Studio Chair for SIGGRAPH 2000, is making the first ever Call For Participation for The Studio. You can get involved at www.siggraph.org/s2000/cfp/studio/.

*—Chris Tome*

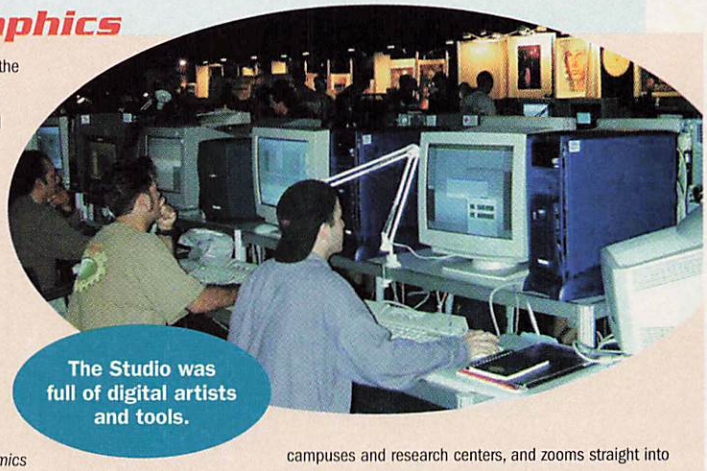
## the electronic theatre & the story of computer graphics

The best thing about SIGGRAPH 99 being at the Los Angeles Convention Center is that the Electronic Theatre wasn't there. A short bus ride whisked attendees to the historic Shrine Auditorium, the neglected-but-still-fabulous home of the annual Academy Awards. In those historic seats, short on leg room in the balcony, we saw SIGGRAPH's annual showcase of the best in CG animation.

New this year were Best of Show and runner-up Jury Prize awards, as selected by a committee of seven pros from the field. The Oscar-winning warm-n-radiosic *Bunny* by Chris Wedge and Blue Sky Studios took top honors, and the Jury Prize went to *Masks* by director Piotr Karwas, a compelling story of one faceless man's search for identity by carving masks.

The 43 pieces in the Electronic Theatre spanned student films, clips and construction shots from feature films, academic animation, shorts from big studios, shorts from tiny studios, and commerical work. The event was virtually hosted by Leon Gerald, star of Mitch Butler's short *The Smell of Horror*. Being a virtual host is a tough gig, but Leon's part-scripted, part-live frantic antics between clips got some laughs.

The ET is not what it once was—scientific visualization and research-centric advances in animation technology. The commercial aspect of CG gets more attention each year. We saw ILM fill the D-Day coastline with digital invading Allied ships and troops for *Saving Private Ryan*, among its several ET features. Visualization was still well represented by *Breaking Objects* from James O'Brien and the Georgia Institute of Technology and *Galaxy Cluster Dynamics* from John Dubinski and the Pittsburgh Supercomputing Center.



The Studio was full of digital artists and tools.

*The Story of Computer Graphics* is a documentary narrated by Leonard Nimony that debuted at SIGGRAPH 99. It focuses on the humans rather than the computers, the people who built the technology rather than the machines themselves, which was a refreshing approach to a techy subject. The story goes back to 1951, when the government used graphics on radar screens to track aircraft entering U.S. airspace, whizzes through college campuses and research centers, and zooms straight into the Hollywood mainstream.

The history of CG is so big and involves so many people that one interpretation can't satisfy everyone ("Why didn't it include the Such-And-Such 8630? Everyone knows that was the turning point"), but *The Story of Computer Graphics* did a good job in following the advancements by key people, including Ivan Sutherland, Pierre Bezier, Jim Blinn, and Ken Knowlton, as they made better machines to help them create what they saw in their minds.

*—Matthew Hoover*


*The Guardian*, created with MetaCreations Carrara™ by artist **Heather Dunnigan** ©1999

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lenges. The SpiDDR offers integrated storage, I/O, and networking for high-end film, video, and audio projects. Consensys showed their RAIDZONE line of disk arrays, ranging from the internal 32GB Can Of RAID, priced at $2,795, to the 585GB Stack Of RAID, at $43,200.

LEGASYS International announced their new reseller relationship with ASACA/SHIBASOKU Corp., which exhibited the TeraCart Digital Virtual Library (a 1.3 to 7.54 Terabyte SCSI-based storage solution). SentryRAID, announced at the show by Storage Concepts, is a real-time Fibre Channel removable device carrying 72GB of data delivered at 85MB/sec for less than $30,000 (expandable to 144GB).

Other storage activity included Exabyte Corp., showing their back-up drives and libraries, StorageTek, showing Media Vault, and Avid, showcasing some of their networking and local storage solutions.

Storage is alive and well at the low end, too, as affordable RAIDs from companies such as Medea, with its new VideoRaid RT (starting at $2,299), offer a variety of configurations claiming increased speed, capacity, reliability, and ease of use.

**Walt Bransford is an independent software developer living in North Little Rock, Arkansas. Contact him via email at waltb@thrillistic.com.**

## vendor contact info

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Developed by Ton Roosendaal, released by Not a Number
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### HARDWARE

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**GVX210, VX1**
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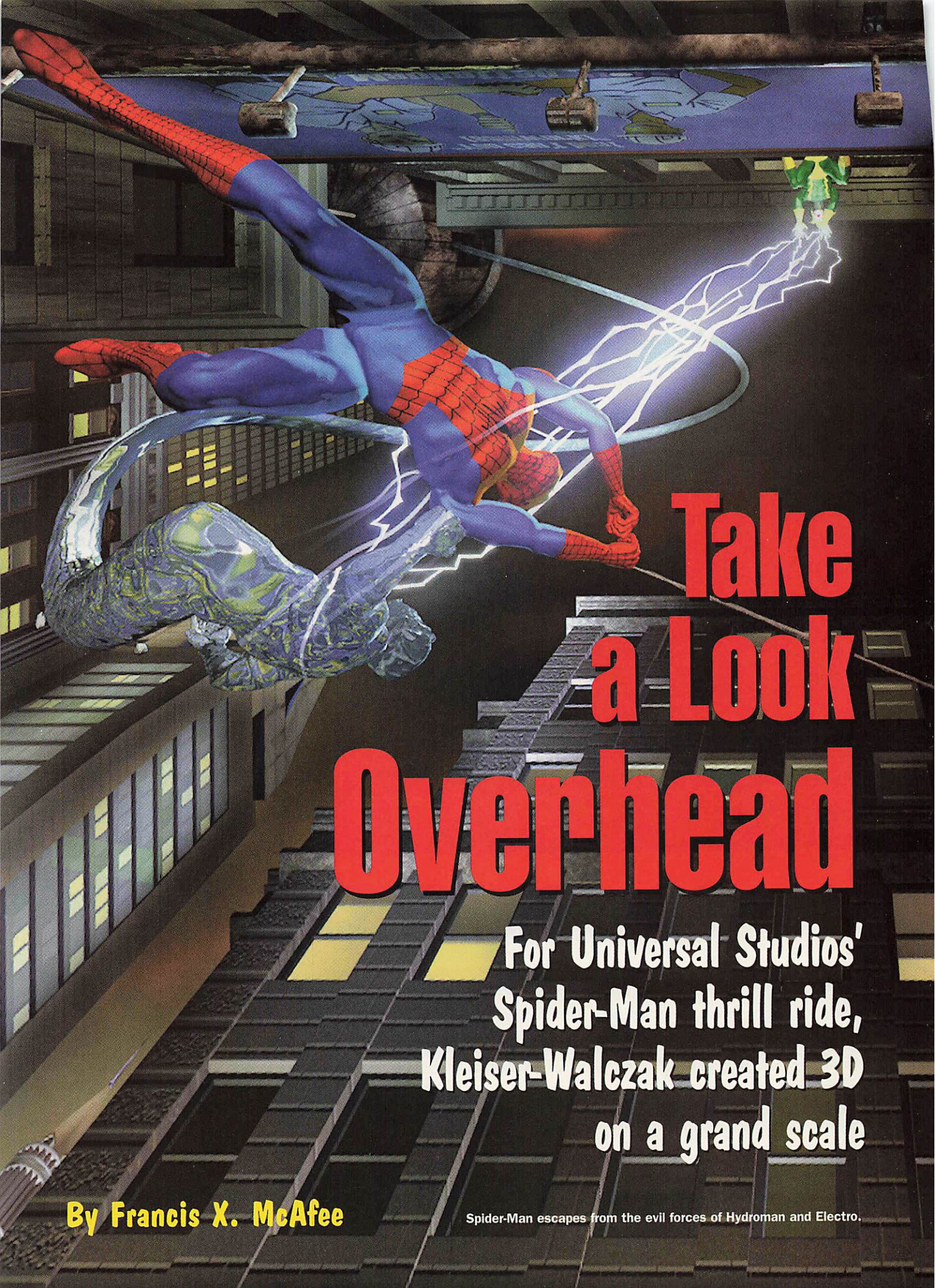


# Take a Look Overhead

## For Universal Studios' Spider-Man thrill ride, Kleiser-Walczak created 3D on a grand scale

By Francis X. McAfee

Spider-Man escapes from the evil forces of Hydroman and Electro.

It's a 45-minute shuffle through the maze at The Amazing Adventures of Spider-Man, an attraction within Universal Studios Florida's Islands of Adventure complex. The journey begins with an Arctic chill in the air-conditioned *Daily Bugle* building, where visitors wind through preliminary displays gathering clues to the story that pits Spider-Man, a superhero with an affinity for arachnids, against a gang of villains dubbed the Sinister Syndicate. A corridor is lined with posters that identify Spider-Man's foes: Doctor Octopus (a.k.a. Doc Ock), Hobgoblin, Hydroman, Electro, and Scream. A photography darkroom houses spilled pans and broken equipment. Passing the newsroom, you notice that one of the synthetic donuts resembles a rubber novelty-store dog turd—and they say he "catches thieves just like flies." Hmm...

For 3D artists and animators who hunger to work on a grand scale, theme-park rides are the ticket. These projects combine the latest innovations in motion control, synchronization, and theatrical effects, resulting in synthetic experiences so vivid they rival reality. Given the nine-figure budgets at stake, success in this medium requires a shelf life longer than all but the most successful movies. In fact, The Amazing Adventures of Spider-Man is expected to continue drawing audiences throughout the next decade.

Since opening last June, the Spider-Man ride has transported thousands of thrill seekers into a surreal environment where CG imagery blends seamlessly with real-world action and props. The ride vehicle roams a 1.5-acre comic-book universe filled with sensory surprises such as fog, pyrotechnics, and multichannel surround audio. Animation is projected in 70mm splendor onto 13 giant screens that are so tightly integrated with the set, you can't tell where the CG ends and the real world begins. Textures from the CG shots are wallpapered on set walls adjacent to the projection screens, and lighting setups are matched precisely between the real and virtual worlds. Video projectors synced to the animation cast real shadows on the set when CG characters jump out at you from the screen.

Leaping CG characters appear all the more lifelike due to the fact that they're rendered stereoscopically. Stereoscopic imagery, which superimposes two separate images to produce a sensation of visual depth, requires that riders view the scene through polarized glasses (see "Deep Imagery," p. 34). In this case, the effect seals the bond between the world generated by the computer and that through which the riders fly, placing them in a truly immersive environment. After experiencing the Spider-Man extravaganza four times in a row, no lesser an authority than Steven Spielberg concluded, "This is the best ride on the planet."

## A Squinch in Time

Created by Universal Studios in partnership with Kleiser-Walczak Construction Company, Spider-Man is one of the most elaborate location-based entertainment attractions ever produced. Building it took four years and cost nearly $100 million. Production spanned the continental United States, from Kleiser-Walczak's main studio facility in North Adams, MA, to their Los Angeles location for 70mm film recording to a secret test laboratory near Orlando.

The driving creative force behind the project was Universal producer and director Scott Trowbridge. Before coming to Universal, Trowbridge built rides for theme parks in Japan and briefly worked with an improvisational comedy troupe in Los Angeles, his home base. "He has a kind of infectious energy, like a kid," says Patrick Mooney, executive producer for special venue entertainment at Kleiser-Walczak. "You need lots of energy to drive people over the long haul."

Another thing you need, apparently, is the capacity not to take "no" for an answer. "We were setting out to do something that everybody said couldn't be done," Trowbridge recalls while sitting at a lunch table outside the ride installation. "It was impossible for so many different reasons."

At the top of the list was getting stereoscopy to retain its dimensional realism from a moving point of view. Conventional stereoscopic imagery is composited with the assumption that it will be viewed head-on. In contrast, riders on The Amazing Adventures of Spider-Man are constantly in motion, careening forward while being pitched around with six degrees of freedom on a vehicle known as the Scoop. To make matters more complicated, some of the projection screens aren't flat. They're concave to heighten the immersive sensation.

Trowbridge uses a copy of *3D* magazine and his sunglasses to explain the problem. The magazine stands in for a 30-foot-high rear-projection screen. The sunglasses represent a spectator in the moving vehicle. "We needed to figure out how to lock this wall in virtual space," he says, referring to the projection screen, "with the solid wall in a practical set, which the virtual wall is rotating and shifting to follow. We had to invent a way to get rid of that distortion inherent in the stereoscopic illusion."

The solution, for which a patent is pending, is a process known as squinching. Squinching distorts the imagery at render time to compensate for shifts in the audience's viewing angle, so when the imagery is projected and viewed from a moving perspective, it looks right. The ride vehicle's motion, the locations of the projectors, the virtual locations of the cameras, and the shapes of the screens were known factors, making it possible to treat them as variables when rendering each frame. In the end, the team built a practical model to proper scale and performed iterative tests until they fig-

ured out exactly what needed to happen.

Trowbridge says he took the idea to unnamed visual effects experts in Hollywood and explained what they wanted to do. "They looked at us as if we were insane and told us squinching wouldn't fix the problem," he recalls.

A key figure in resolving the conundrum was Hoyt Yeatman, a principal of DreamQuest. Described by Trowbridge as a "supernerd—in the best sense of the word," Hoyt flipped through books of calculus to see what algorithms might work to warp the imagery appropriately as an audience moved around the screen. Once he had proved through testing that it could be done, Hoyt went back to his own productions. At this point, it was necessary to find someone to execute the idea.

## Enter Kleiser-Walczak

Acting on the belief that large production houses weren't well suited for innovation, Trowbridge surveyed smaller CG companies and eventually settled on Kleiser-Walczak. "They were able to work with us in a free-form kind of way," he says, "doing a lot of R&D and experimentation and being very responsive to demands we were making that are not normally part of the film-making process."

Another attractive attribute of the company was its remote location in the Berkshires of western Massachusetts, where Universal felt the project would be safe from prying eyes. During production, no mention of Spider-Man was allowed, and the project was referred to as Project 706. (Despite intensive security precautions, photos of the ride's interior leaked onto the Internet during testing in Orlando.)

A husband-and-wife team, Jeff Kleiser and Diana Walczak founded Kleiser-Walczak in 1987. Kleiser, who worked on the animation in Disney's CG classic *Tron*, and Walczak, a sculptor, set out to create digital models for motion picture production. Before long, they racked up credits that include *Judge Dredd*, *Stargate*, *Honey, I Blew Up The Kid*, *Mortal Kombat: Annihilation*, *Clear and Present Danger*, and *The Rage: Carrie 2*. More to the point, they worked on Honey I Shrunk the Audience, an attraction at Disney's Epcot Center, and Douglas Trumbulls' Luxor Trilogy at the Luxor Hotel in Las Vegas, both of which employed stereoscopic imagery.

When Kleiser and Walczak joined the project in April 1996, Universal was in the midst of building the scale practical model.

**Donning 3D glasses, audience members can see Spider-Man in all his steroscopic glory in this new thrill ride at Universal Studios Escape in Florida.**

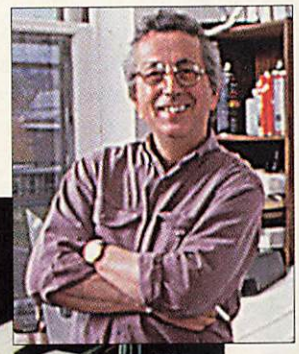
Based on the model, Scott Trowbridge and Universal art director Thierry Coup produced blueprints. Using auto·des·sys form·Z, Kleiser-Walczak built a CAD model from the blueprints to visualize the vehicle's path and the dimensions and logistics of the screens and projectors. This data helped them determine the values of variables in the squinching process, retrofit the lighting, and storyboard the film.

At this point, production began in earnest on the ride's 13 CG shots, co-directed by Kleiser and Walczak. Key players on the Kleiser-Walczak team included animation supervisor Derald Hunt, technical supervisor Jeffery A. Williams, programmer and squinching developer Frank Vitz, and Patrick Mooney, executive producer for location-based entertainment. In addition, the team comprised thirty or more animators, designers, and technicians. Kleiser-Walczak stationed an animator in Orlando full-time during the first few months of production, and members of the team traveled to Orlando at least monthly for the duration.

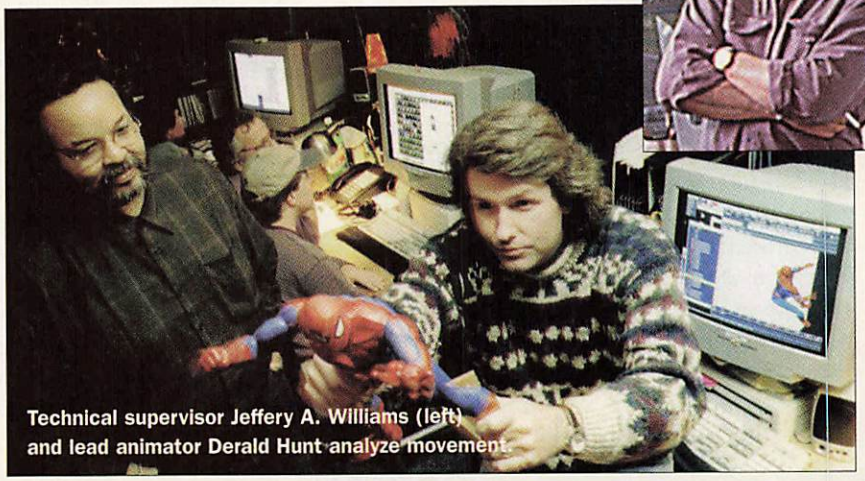
## Changing Apps Midstream

Creating the CG sequences involved the full arsenal of Alias|Wavefront's tools—at the time, a collection of software modules developed separately by Alias, Wavefront, and the newly acquired Thomson Digital Image (TDI). Alias Power Animator was used for modeling, animation, and rendering. Wavefront Kinemation was used for character animation, Dynamation for dynamic effects, and Composer for compositing. Finally the team employed TDI Explore, a tool suite that included 3Design for modeling, Anim for animation, and Interactive Photorealistic Renderer (IPR) for rendering. (Maya users will note that IPR is among the latest and greatest from Alias|Wavefront.)

Although these tools were powerful, shuffling data among them was no picnic, espe-



**Art director Kent Mikalsen at the MASS MoCA offices of Kleiser-Walczak.**



**Technical supervisor Jeffery A. Williams (left) and lead animator Derald Hunt analyze movement.**

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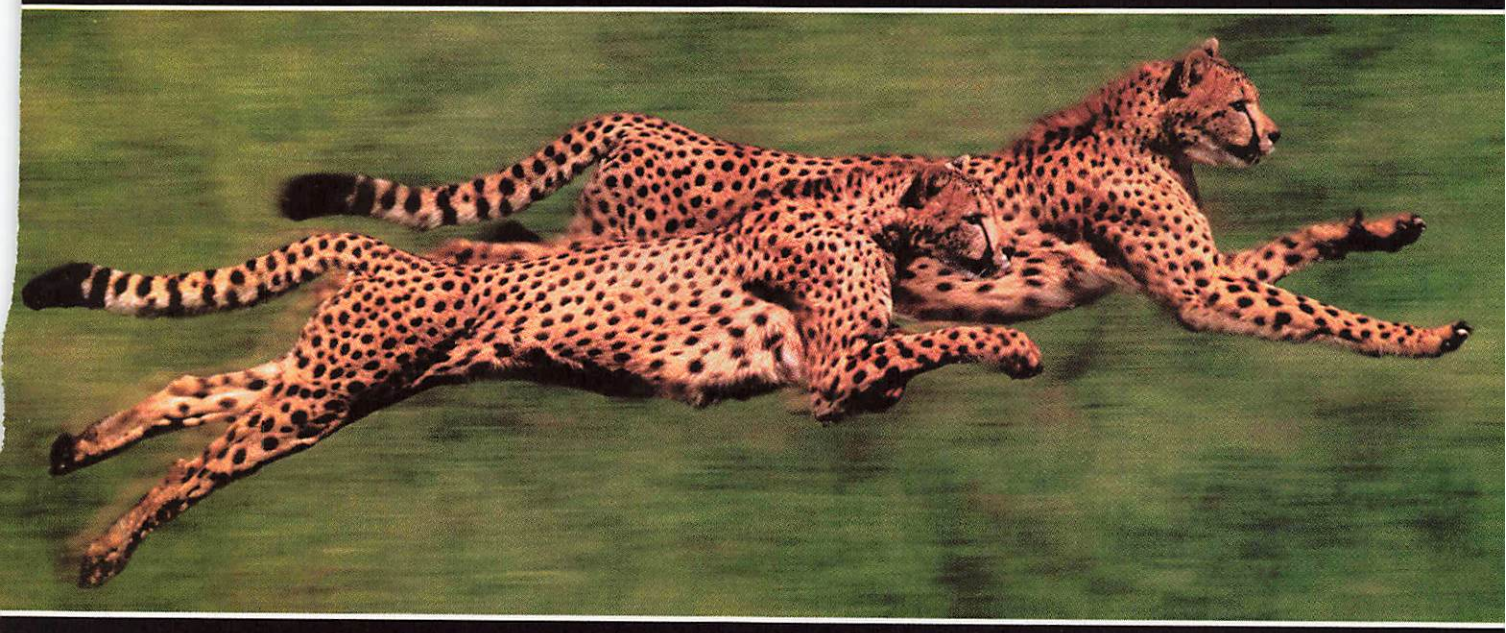

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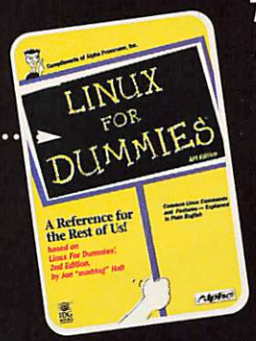


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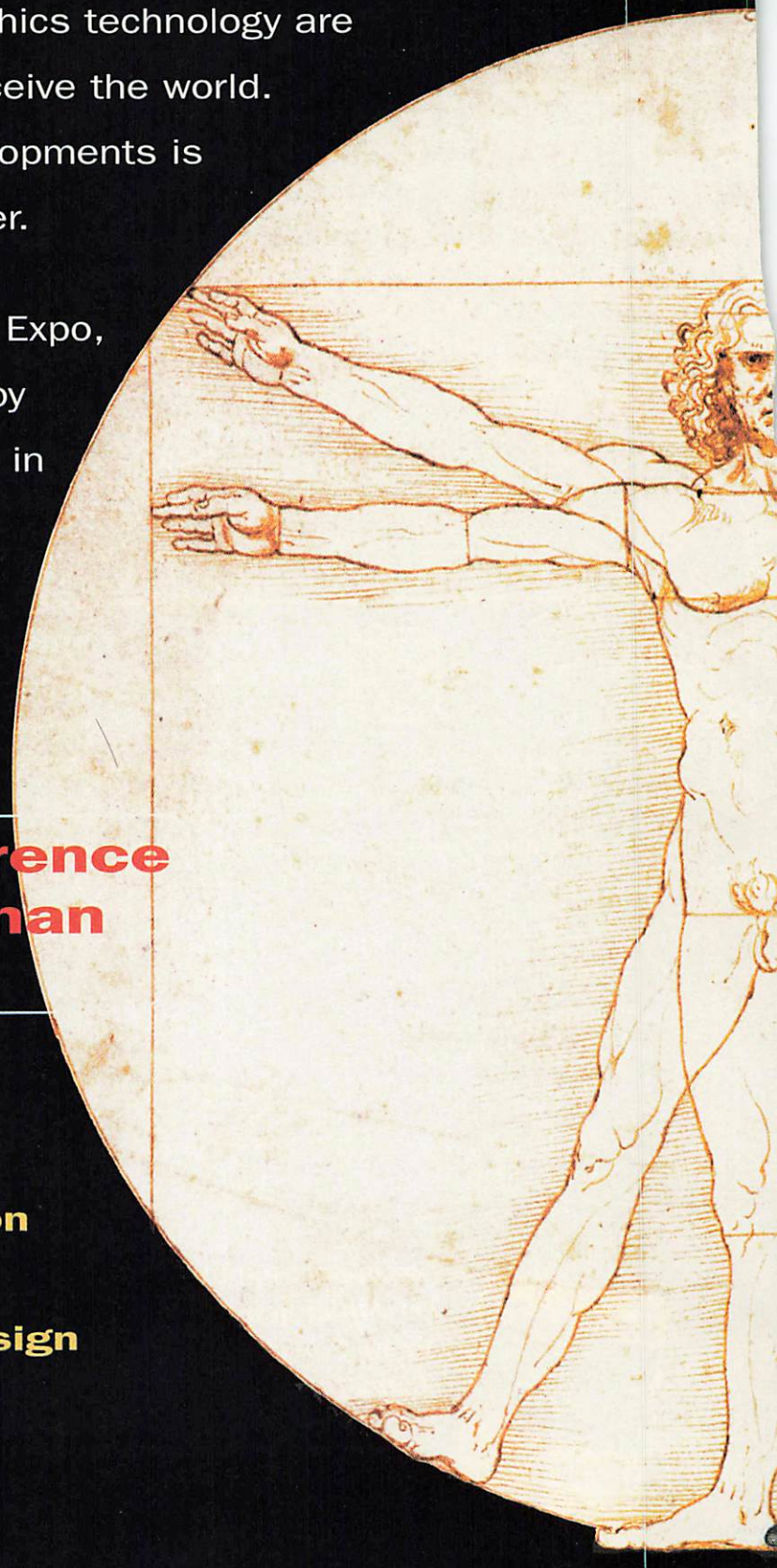

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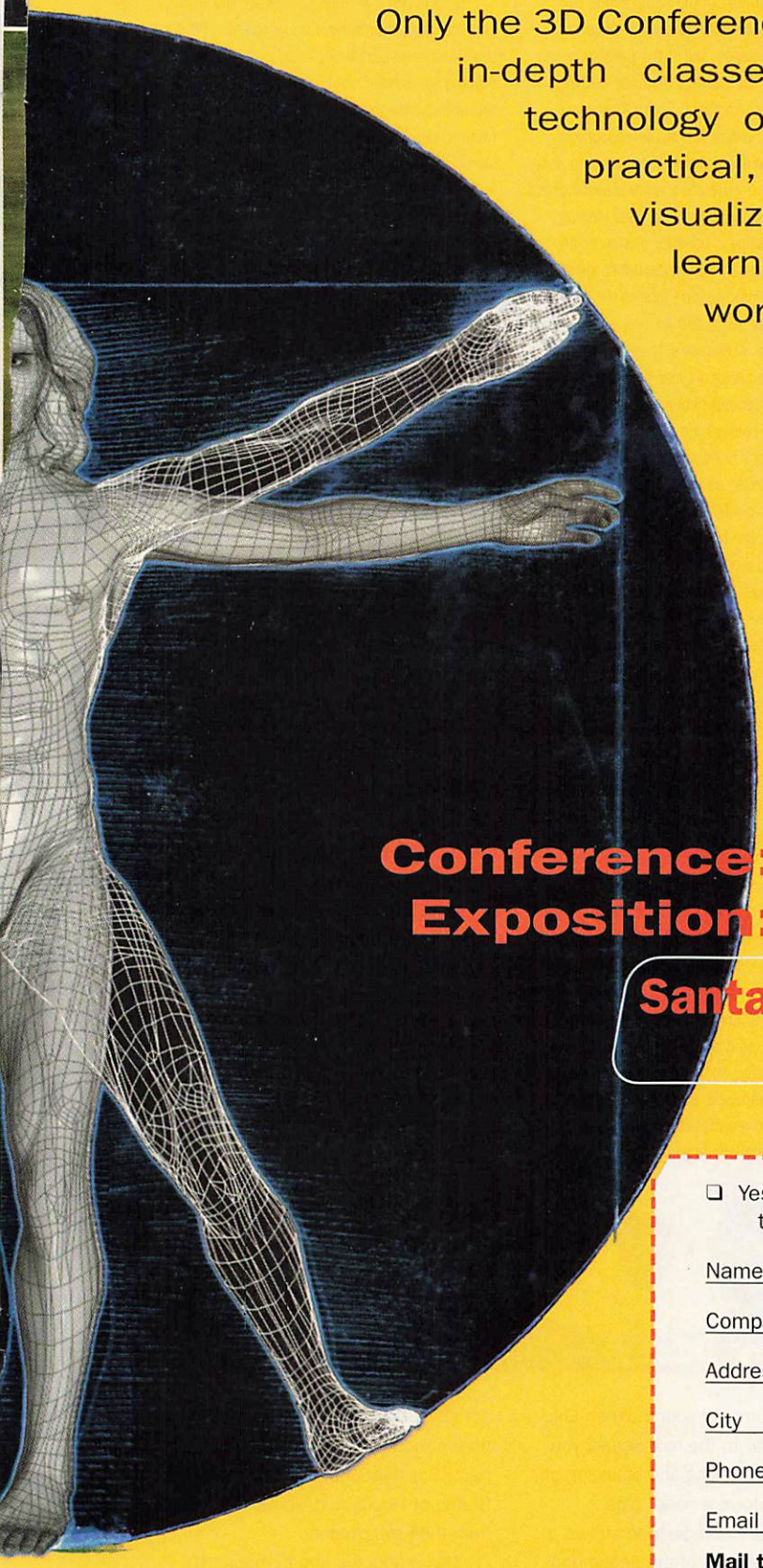

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cially given the different file formats used by the original developers. The team developed its own custom file format translation software, but it was far from user-friendly. Kleiser-Walczak signed on as a Maya beta test site as soon as the opportunity presented itself, going through 11 beta releases as Spider-Man progressed.

Switching tools midstream may defy common sense in most production situations, but the gamble paid off. "The key was to have some breadcrumbs to find our way back to our known, released software," recalls technical supervisor Jeff Williams. "Being able to get back to Kinemation or Explore was important in case the beta code blew up. It was like testing the water. Stick one toe in and see if you can get it out, stick your shin in and see if you can get it out, and keep going little by little. Before we knew it, we had scenes entirely produced in Maya." Spider-Man was Williams' first supervisory role in a CG project, so the changeover was especially nerve-wracking for him.

The scripting capability provided by MEL (Maya Embedded Language) made it possible to customize the GUI for greater productivity. "We created some custom tools for the animators that enabled them to switch between low-res and high-res characters easily, or turn off aspects of a character that weren't necessary for animating and turn them on for rendering," Williams explains. In addition, MEL-driven tool windows were built that included sliders for facial expressions, pivot point manipulation, twists, joint rotation, and activating IK.

Maya's file referencing capability made it possible for several animators to work on the same character at the same time by substituting files. For instance, one would tweak body motion while another worked on facial animation for the same scene. Assembling the final scene was a matter of referencing the latest facial animation, lighting, and flexing files simultaneously.

## Animating for the Big Screen

Finally, you make it to the front of the line and jockey for position at the sweet spot in the middle of Scoop. Synced within milliseconds of the onscreen story, the Scoop's programmed motion adds the thrill-ride equivalent of finishing effects. Three onboard computer systems control vehicle choreography. Thirty-two speakers mounted at strategic points deliver 10 channels of audio, providing high-fidelity surround sound. When Electro blasts you away to the next scene, you can feel the vehicle falling and bouncing off walls as it spins down a sewer pipe.

In the first scene, Spider-Man strikes a heroic pose on the front of the Scoop and addresses the audience. He points a 3D finger in your face and tells you that this could be the most dangerous night of his life. The nasty Sinister Syndicate has stolen the Statue of Liberty and we must retrieve it from their evil clutches.

This marks the first of many "3D moments" the Kleiser-Walczak team created

## deep imagery: a stereoscopy primer

by Michael Kobrin

Stereoscopic imagery has existed since 1838, when Charles Wheatstone discovered that he could create an illusion of visual depth by presenting each eye with an image of the same scene from a slightly different angle. (The horizontal offset between the two images, called the parallax or base, is based on the average distance between a pair of human eyes, roughly 6.5cm.) After more than a century of novelty status, stereoscopy is gaining a higher profile among 3D artists and animators who want to generate a more realistic effect than that produced by conventional 2D viewing.

Today, stereoscopy is used for architectural walk-throughs, medical imaging, scientific visualization, geographical information systems (GIS), location-based entertainment, and games, not to mention the occasional IMAX movie. To get a sense of how it works, try focusing on your forefinger and note that the background becomes a double image. Now focus on the background and watch your finger double. Not everyone sees precisely the same effect, but this exercise should convey the basic idea. Stereoscopic content can be found on several web sites, such as the Mars Pathfinder site, which offers stereoscopic views of the Pathfinder mission (http://mars.sgi.com/vrml/qtvr_stereo.html).

To produce your own stereo images, you need to create a separate image for each eye with the proper parallax. Capturing photographic source images can be done using a stereo camera with two lenses set at the proper angles. Alternatively, you can use two separate cameras set at the proper angles or a single camera moved horizontally between shots. Using a 3D application, of course, you can bypass the need for physical cameras by rendering two views of the same scene.

Once you have the images, the simplest way to present a stereoscopic experience is free viewing: You simply train your eyes to focus (or unfocus) on a pair of images presented side by side until your brain combines them into a single 3D image. This method is bound to tax even the most patient audience, though, so it pays to consider alternatives. Anaglyph stereo images are color-adjusted, offset, and superimposed, and viewed through color-adjusted glasses that filter the colors (usually the classic red/blue lenses you'll remember from cheesy sci-fi movies if you lived through the 1950s). Polarized stereo images are viewed through polarized glasses.

Liquid crystal shutter glasses are the most sophisticated alternative. Connected to a PC via the video card, parallel or serial port, or wireless infrared transmitter, shutter glasses alternately reveal and hide the image for each eye. This method can be used to display several types of stereo images including page-flipped (left and right images alternate) and line-alternate (left images are presented on odd lines, right images on even lines). Makers of shutter glasses and other 3D viewing hardware include StereoGraphics (www.stereographics.com), VRex (www.vrex.com), and Metabyte (www.wicked3d.com).

It's not difficult to get started experimenting with stereoscopy. Most popular 3D apps support one stereo format or another:

- DepthCharge MAX from VRex (www.vrex.com/apps/html/3d_studio_max.html) is a plug-in that controls Discreet 3D Studio MAX's stereo cameras and supports multiple stereo output formats.
- NewTek LightWave offers stereoscopic rendering. In addition, NewTek offers a plug-in called Stereo Composer that generates a red/blue-shifted image (anaglyph) for use with red/blue 3D glasses.
- Strata offers stereo rendering in Studio Pro 2.5 and claims superior results thanks to an intensive R&D effort.
- Avid Softimage can render stereo images with the help of NStereo, a plug-in shader that can render stereo images with having to modify camera positions or add another camera to your scene.
- Play Electric Image and Pixar RenderMan can render stereoscopic images in various formats.
- 3D Stereo Image Factory from SOFTreat (http://m1.aol.com/threedr/index.htm) generates various types of stereo output from a pair of images, including interlaced images for most types of shutter glasses.
- Alias|Wavefront Maya is the only major exception, but the company is developing a MEL script to support stereo output.

To investigate stereoscopy further, a wealth of information can be found at www.stereoscopy.com.

to exploit the stereoscopic effect. The team found that the relationships between right and left images were quite different when producing stereoscopic imagery for large-screen presentation as opposed to a computer screen—empirical testing was necessary to discover the appropriate parallax (distance between the cameras) for the large screen. Negative parallax was applied to make the character appear to extend in front of the screen. For instance, for a character to be perceived as jumping off the screen, the viewer's eyes must converge on the subject and cross. Fortunately for this project, the larger the viewing area, the less eyestrain is associated with viewing stereoscopic imagery.

A special challenge of animating for the ride was that close-ups were off-limits. Given the high degree of integration between the projection screens and the sets, it was necessary to keep the characters entirely in frame at all times. "You can't crop any parts of the characters or the 3D illusion will be lost," according to Derald Hunt, animation supervisor and Spider-Man fan. "And you must check both the left- and right-eye frames to keep the character in frame." Hunt got his start at Turner Entertainment in Atlanta, GA, where he worked on The Cartoon Network, TNT, and other commercial projects. "A chance to work on Spider-Man was like a dream come true," adds Hunt, who confesses to being "in love with comic book superheroes."

"In this shot, the challenge was incorporating those heroic poses, the way heroes carry their weight," he says. "No regular person moves this way—lots of body language, superheroic motion, jumping across rooftops, and all that."

Animating Spider-Man's archrivals also presented unique challenges. "We had to define personality through motion," Hunt continues. For instance, the animation team determined that Doc Ock, with his mechanical tentacles and giant antigravity gun, should be more menacing than graceful. Instead of propelling himself across buildings with a refined stride, he stomps and crushes anything in his path. Care was taken to make the gun look heavy, affecting the way Doc Ock interacted with it.

The original plan was to animate Ock and his pals using motion capture, and the team went as far as hiring a martial-arts expert to perform the actions. When they tried it, though, they encountered one of the "d'oh!" experiences without which no production effort is complete: You can't create superhuman motion by capturing the motions of normal humans. To animate a character who has the strength of ten men and swings from spider webs, it's necessary to do it by hand. Keyframing required more artists and animators than the directors had anticipated, but they managed to take it in stride.

**A concept sketch and final frame showing the audience's point of view during the 400-foot sensory drop.**

Maya saved the day when it came to creating the blobby particles that coalesce from water into the Hydroman character. Initially, Frank Vitz used Explore's blob modeler to make the shapes. Then he used the blob renderer, a PERL script that comes with Explore, to generate a sequence of geometry files that can be rendered in IPR. Maya didn't yet include a blob modeler, but it did provide blobby particles in an integrated modeling/animation/rendering environment that Vitz found much more inviting. Switching to Maya, he accomplished the task by emitting thousands of blobby particles that accrete into Hydroman's polygonal shape using vortex and turbulence attribute variables. Smaller-sized particles provided surface detail over the armature. After forming the watery character, he made the particles recede and dissolve into the high-resolution polygon model of Hydroman.

70mm, eight-perf film calls for extreme detail, especially projected on screens as tall as 30 feet. During production Vitz worried that Hydroman wasn't sharp enough when projected on a 30-foot-high screen. However, he found that once the sound and ride motion were added to the experience, the shortcomings of the imagery weren't noticeable. It takes several rides before the sensory overload subsides enough to see things that clearly.

**Striking Pavement** The finale of the ride experience, and most memorable part, comes at the end when Doc Ock uses his antigravity gun to levitate the audience to the rooftops of skyscrapers. Then, in a friendly sort of way, he switches off the power and you drop 400 feet staring squarely at the pavement below.

As you fall to the ground, you may believe that your body is being hurled through the air, but in reality you drop only a few inches. You shake, tilt, turn, and spin, but most of the ride is in your head. Of course, you wouldn't know it from the feeling in your stomach as windows whiz by and you bounce off buildings on your way down. Don't worry, though. Spider-Man saves the day, catching you in a web before you hit concrete.

Animating this shot was the work of technical supervisor Jeff Williams. After working for 12 years at EdiTel and then telecommuting from Chicago to Kleiser-Walczak to work on the Luxor project, he moved to North Adams seven years ago. For Spider-Man, he kept the pipeline moving, printing test shots to film, sending them to Orlando, and testing them on the ride. Once the ride projectors were locked in, he oversaw final rendering and transfer to film.

During his first test ride in Orlando, when he reached the plunge-to-the-pavement shot, he recalls, "I couldn't believe how quickly I was drawn into that effect." He knew exactly what would happen, and it still scared the daylights out of him.

To make the shot to look as real as possible, the team utilized a toroid (donut-shaped) screen. This screen shape exaggerated the effect by immersing the audience more fully in the film, but made squinching more difficult. After analyzing vectors of the screen and drawing pictures, it still took Frank Vitz about a month to work out the algorithm.

**Render Time** Between squinching and the sheer size of the scene files themselves, rendering was a time-consuming process. "At a certain point we were rendering less than a frame a day," recalls technical supervisor Jeff Williams. How did he overcome that challenge? "We waited," he replies. "Who knows what the problem was? It was probably a memory leak, but we were on a very tight deadline from Universal and we couldn't afford to dive into that file and find out what was going on. We just had to let it cook. As long as it was making frames, we were happy."

The render farm consisted of one six-processor SGI Origin 2000, two four-processor Origin 400s, and nine dual-processor Octanes that doubled as animation workstations. Proprietary network rendering software watched the animation workstations for mouse movement, and when a station was idle for 30 minutes, it would tell the server to send over a frame. By midnight, all the processors in the house were busy rendering.

The average scene took 209 hours to render, and there were 13 scenes. All told, the final rendered frames amounted to 300GB. It was, Williams says, "a crushing ton of data." And it all had to go from Massachusetts to Los Angeles, where file transfer took place via T1.

**Caught in the Web** The Amazing Adventures of Spider-Man may look like just another kiddie ride, but make no mistake about it: The production effort was as intensive as many high-end military applications. The custom code had to work as well in practice as it did in theory. The artists and animators had to pay extreme attention to detail for the stereoscopy to work. Every frame of animation had to match the motion programmed into the ride vehicle.

"Theme park ride films are fun because you have more design input than you normally would for a feature film," Jeff Williams says. "But the recognition isn't as great. It's a major accomplishment that no one has any idea about because there are no credits."

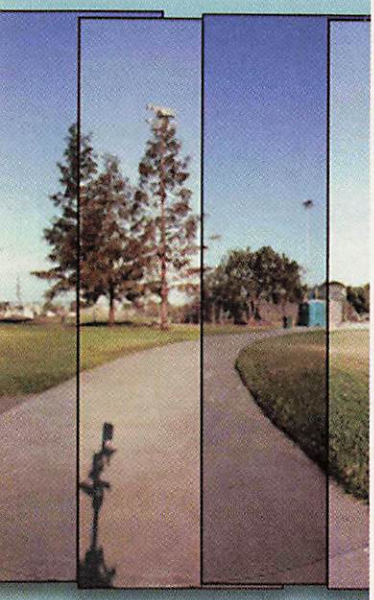
Where the arts meet technology, the greatest satisfaction often lies in meeting the challenge, and Spider-Man is no exception. "There's a great degree of confidence that one has after accomplishing something like the Spider-Man ride," Williams continues, "so our chests are poked out pretty far right now."

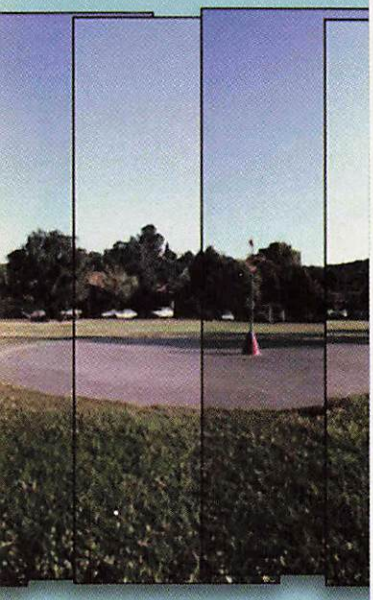
If he could change anything about the project, Williams would have pressed for more explicit direction from Universal. "It always helps to know what's required of you before you have to make it," he explains. "They tend, like most clients, to design on the fly. I can understand that from a creative standpoint, but the more you know in the beginning, the better off you are. There's no replacement for good planning up front."

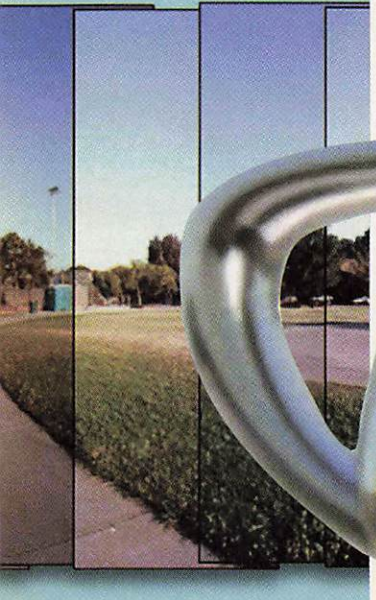
The success of the Spider-Man ride has positioned Kleiser-Walczak squarely within a niche in location-based entertainment. "This experience has made us very well suited to designing the next-generation film rides," Walczak states. "A lot was learned in three years. We put together an incredible team and they know how to work together. If somebody came to us now and said, 'design an attraction,' we would be able to jump all over it and work ten times faster than we did when we started Spider-Man."

From the beginning, the production teams of Universal and Kleiser-Walczak set out to pioneer a new technical feat while giving audiences an experience worth repeating. Several viewings are necessary to appreciate this project's distinctive blend of the real and the virtual. The Amazing Adventures of Spider-Man rewards the attention with an experience that hints at the enormous potential of large-format 3D in an immersive environment.

**Fran McAfee is a professor at Florida Atlantic University in the computer arts MFA program. He's also associate director for the university's Florida Center for Electronic Communication (www.animasters.com), where he has been researching computer software applications for over eight years. Email him at mcafee@fau.edu.**







*by Alex Lindsay*

# Reflections of Reality

## How do you make a CG object blend into a real-world scene? Break out the QuickTime VR tools.

Many of us struggle to create imagery that matches ever more closely the look of reality. We spend days building bump maps, specularity maps, and diffuse maps, only to add an object to a scene and find that it doesn't look right.

What's missing? With highly reflective objects, sometimes it's the world itself. You know, the world that's supposed to be surrounding your little bauble. The usual way to reflect the surrounding environment in a CG object is to apply an image of the surrounding environment, or even a generic image, as a reflection map. Often this approach is adequate. But when you're aiming for a photorealistic result, especially compositing CG objects into a real-world scene, it can fall short of the target.

Creating realistic reflections of a real-world environment on CG objects is easier than you might think. All it takes is a simple camera rig and inexpensive, easy-to-use software.

Here's how it works: You take a bunch of photos, stitch them together into a single image, and you use them as a spherical reflection map. Too fast? OK. Let's back up and slow down a little. We'll create a realistic reflection map on a 3D teapot that we'll composite onto the top of a real-world pillar in a park.

**Capture It** It all starts with a camera, a tripod, and a QuickTime VR (QTVR) camera rig. QTVR is a subset of Apple's QuickTime architecture. It maps a 360° panorama, either rendered directly or stitched together from a series of contiguous images, to the interior of a sphere, creating what is known as a QTVR panorama. Using a QTVR viewer, a user, situated in the center of the sphere, can view the scene in all directions. (For more about

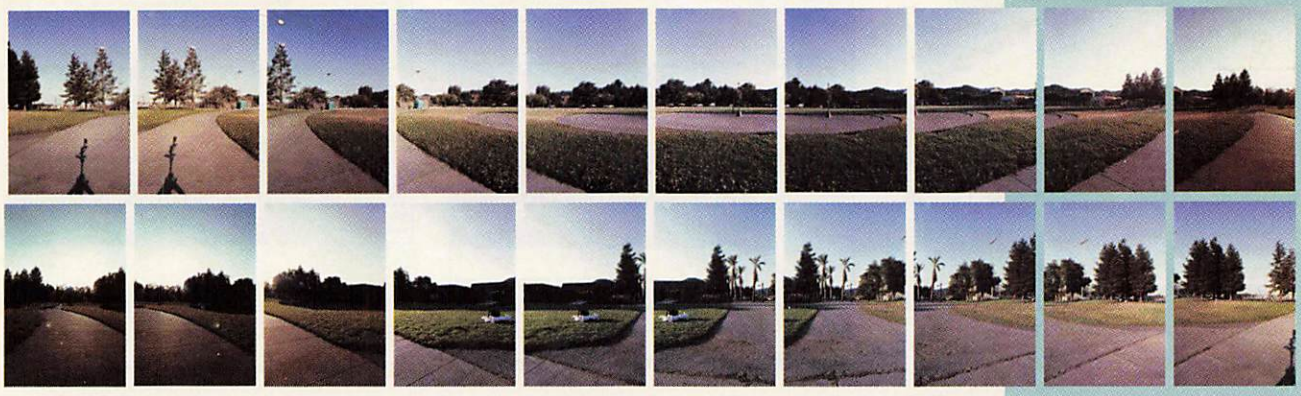


**FIGURE 2. Thumbnails of the photos used to create the panorama.**

**FIGURE 1. A Kaidan QTVR rig was used to shoot the panorama. While not entirely necessary, a QTVR rig makes the task much easier by letting you set incremental camera angles precisely.**

QTVR, I recommend *The QuickTime VR Book* by Susan Kitchens, published by Peachpit Press.) For the purpose of this article, we're not actually using QTVR. Rather, we're taking advantage of tools that have grown up around it.

The idea is to create an accurate 360° panorama of the scene that will surround your object. It's possible to do this using a normal tripod, or even by hand. However, if you find yourself creating lots of panoramas, you're going to want to use a QTVR rig to guide the camera (see "Get Rigged," p. 41). A rig made by Kaidan was used for the project discussed in this article (Figure 1). This lets you take a number of photos of a contiguous area while rotating the camera angle by a consistent amount in each shot. You don't need to take very many pictures. Eight to 12 will be plenty (Figure 2), as long as they cover the scene all the way around. Taking them in order will make them more manageable as digital files.

The camera should be positioned as near as possible to the virtual position of the CG object. This way, the reflection will accurately display the object's surroundings. Matching the position isn't always possible, but the closer you get, the more accurate the reflection will be.

A film camera was used to create the examples presented in this article. Any digital camera with a megapixel CCD should capture plenty of information for the purposes of building reflections, but a film camera provides a better choice of lenses. Something close to 28mm works best. If you capture on film, don't bother to make traditional prints. Instead, have the images transferred directly to PhotoCD format. It's a little more expensive, but it's a whole lot easier to manage in the digital domain.

**Stitch It** Once the photos are in digital form, it's time to stitch them together into a 360-degree panorama. Believe it or not, a number of applications do this automatically (see "We Need a Stitcher," p. 41). Nearly all of them do it as part of the process of creating QTVR files, but that doesn't mean you can't stop short and export the panorama for your own purposes.

For this article, VR PanoWorx from VR Toolbox was used (Figure 3). It's inexpensive, easy to use, and very effective. In VR PanoWorx, you simply set the focal length used during the shoot and the number of pictures taken, then open the photos. You can grab them all at once if you took them in order, or at least named them in order.

VR PanoWorx tries to match each photo to the next. It's tolerant of inconsistencies in exposure, and if the pictures were taken well, it will line up the details. You may have to guide the software here and there, but if you've used a QTVR rig, the automatic version will probably be close enough (Figure 4). Remember, you're building a reflection map, not a Rembrandt.

Next, the program attempts to blend the photos to match their exposure (Figure 5). Once again, this is a fairly automatic process. Some shifts may be apparent, but it's unlikely they will affect the final work. From here, you can export the finished panorama (Figure 6) in virtually any image format.

One of the limitations of this technique is that the camera can't capture data directly

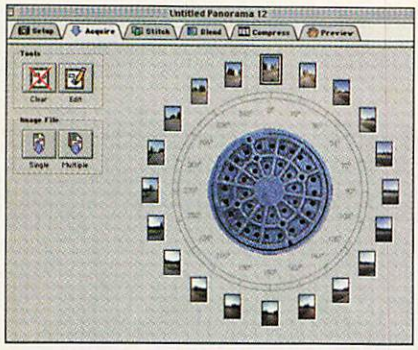


FIGURE 3. The panorama photos after importation into VR PanoWorx.

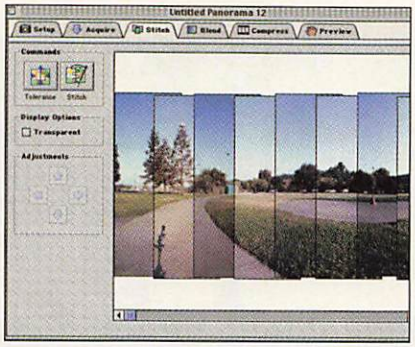


FIGURE 4. VR PanoWorx automatically aligns the pictures into a single image.

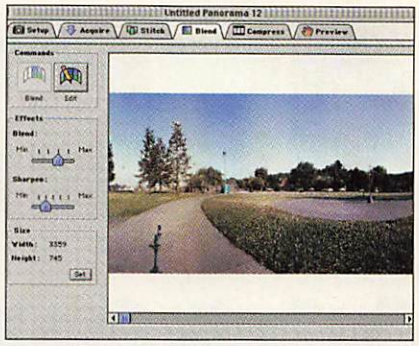


FIGURE 5. After aligning the photos, VR PanoWorx blends them automatically.

above or below the subject. To handle this, you'll need to touch up the panorama exported from VR PanoWorx using an image editor such as Adobe Photoshop.

When you load the panorama, change the canvas size to an aspect ratio of 2x1, the area you need for the reflection map (Figure 7). A white gap will appear on the top and bottom. To fill the spaces, copy other areas of the photo using Photoshop's Clone tool (Figure 8). There's no need to work hard here. Just fill the upper area with an appropriate color and texture, in this case swatches of blue-and-white sky. The lower area is usually more difficult. Once again, remember, no one will see the finished product directly, so don't waste a lot of time being a perfectionist. You're going over the top by using this technique in the first place! Export it in a format appropriate for reflection mapping in your 3D app.

**Map It** The next step is to line up the CG camera with the real-world camera that shot the background. One of the easiest ways to do this quickly is to build a plane over the background that represents the surface on which the CG object will rest—in this case, the top of the white pillar. Rotate the camera until the plane matches the real-world surface. Set the object—the omnipresent CG teapot—on the plane.

Now it's time to apply the panoramic reflection map image as a spherical reflection map. To position it properly, you'll need to rotate the image about the Y axis until the reflection works. You can save a little time by animating the rotation over one second at intervals of 12° per frame (360° at 30fps). Render the animation with the background turned on. Now view the result. You'll see the reflection move from something that looks wrong to something that looks fairly correct.

Go to the frame where the reflection works and note the rotation value. Eliminate all the keyframes and type in that rotation value as the reflection map's Y rotation. Now the reflection is synchronized with the scene as a whole (Figure 9). By the way, this is a great way to get reflections right whether you're using the QTVR method or not.

**Polish It** Are we there yet? Not quite. A few additional steps are required to make a

FIGURE 6. The finished panoramic image.

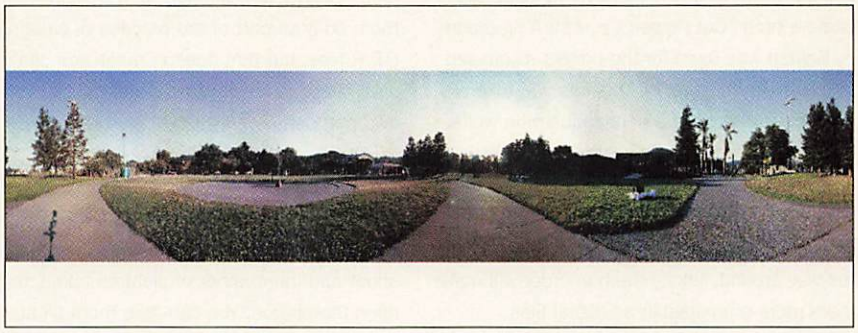


FIGURE 7. In Adobe Photoshop, the canvas is increased to the proper size for a reflection map, leaving borders at the top and bottom of the panorama.

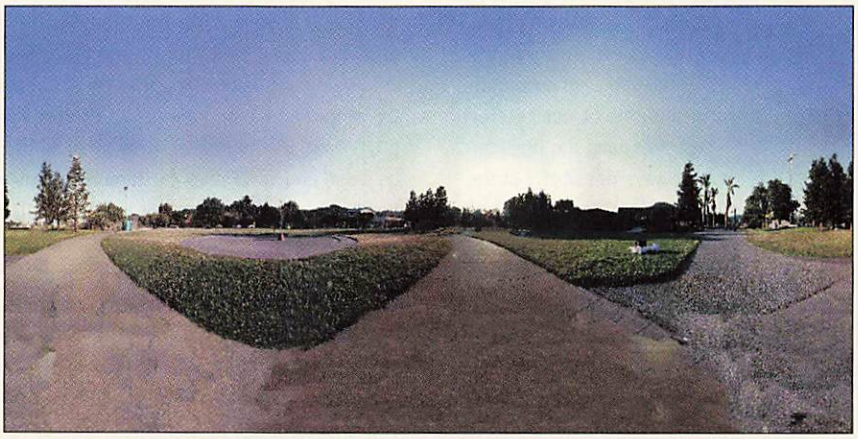


FIGURE 8. Using Photoshop's Clone tool, the upper and lower borders are filled with sky and ground.

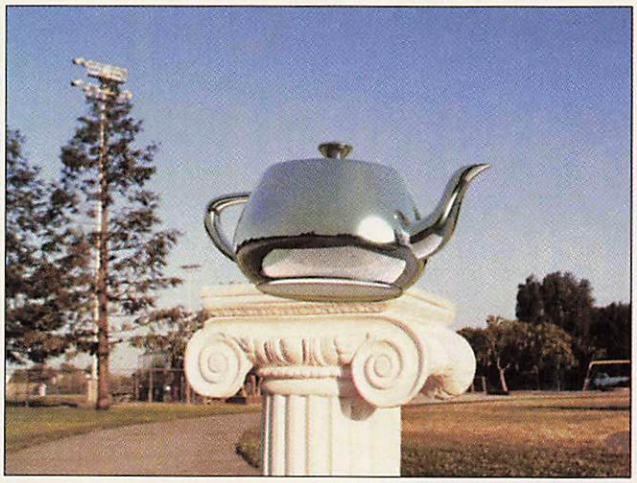


**FIGURE 9. The CG object has been composited into the scene, but work remains to be done before it looks like it belongs there.**

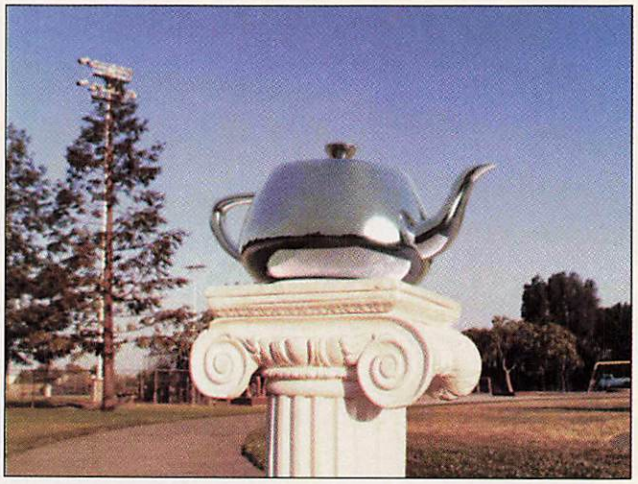


**FIGURE 10. The final image. Light Wrap, blur, and grain have been added, as well as matting the teapot's base to fit the photo.**

picture you can believe in. Since the CG object presented here will sit on a pillar, it's necessary to include the portion of the pillar that will occlude the object. Fortunately, for the purposes of our example, we've already done it—it's the plane we used to align the CG camera with the real-world camera. Things won't work out so conveniently in all cases, so you may need to take an extra step or two to accomplish this in your own scenes.

Now look for differences between the CG object and the real-world background. The CG object is sharper, the edges are cleaner, and it lacks grain. Fortunately, handling these issues is relatively simple. First, add a one-pixel Gaussian blur to match the softness of the background.

The problem with the edges is lack of the typical contamination of any object in front of a lighter background. This contamination is essential to truly integrating a CG element into its environment. The basic concept is to create a new matte that looks like the CG element's matte, but only contains the edge of that matte. The background shows through this matte and screens over the CG element. If you don't want to do all of that work, you can simply get Puffin Designs Image Lounge for After Effects. It contains a nifty little plug-in called Light Wrap that does all the hard stuff for you, allowing you to add this effect with little headache.

Finally, it's time to take care of the grain. A fairly bland sample of the background image is needed. In this case, the sky will do quite nicely. Take a chunk of the sky into Photoshop, make a copy of the image into a new layer, blur this top image by a few pixels, and difference the result over the layer below. This procedure pulls the grain out of the image, eliminating everything else. Now you can now add the grain layer over the CG object so it fits right in.

There you have it: photorealistic reflection of a real-world scene in a CG object (Figure 10). Remember to save all the reflection maps you create. They'll come in handy in other scenes that don't have clear reflections.

If you think this project is daunting, go to the *3D* magazine web site (www.3dgate.com), download the files for yourself, and work through the procedure using your own 3D app. You'll see it's a no-brainer.

*Special thanks to Giles Hancock and Matt Lowery for their valuable contributions to this article.*

**Alex Lindsay is a visual effects artist in Northern California.**

## we need a stitcher

The following image-processing tools are capable of stitching multiple images into a panorama, as described in this article. Most of them do other cool things as well, generally related to QTVR.

**QuickTime VR Authoring Suite**
**Apple Computer Inc.,** 408.996.1010; www.apple.com/quicktime/qtvr.

**iMove Photo Suite & iMove Computer Graphics Suite**
**iMove (formerly Infinite Pictures),** 503.221.2449; info@imoveinc.com; www.imoveinc.com.

**PhotoVista**
**Live Picture,** 408.551.5400; info@livepicture.com; www.livepicture.com.

**Spin Panorama**
**PictureWorks,** 800.303.5400; www.pictureworks.com.

**VR PanoWorx**
**VR Toolbox,** 407.673.0357; info@vrtoolbox.com; www.vrtoolbox.com.

## get rigged

The following equipment was used to create the images presented in this article.

**Hardware:**

**G3 PowerBook**
**Apple Computer Inc.**, 408.996.1010; www.apple.com.

**N70 camera & 28mm lens**
**Nikon**, 516.547.4200; www.nikonusa.com.

**100 ASA Gold 35mm film**
**Eastman Kodak**, 716.724.4000; www.kodak.com.

**KiWi-L QTVR rig**
**Kaidan**, 215.364.1778; info@kaidan.com; www.kaidan.com.

**3046 tripod**
**Bogen/Manfrotto**, 201.818.9500; info@bogenphoto.com; www.bogenphoto.com.

**Firewire 2 Go card**
**Newer Technology,** 316.943.0222; info@newertech.com; www.newertech.com.

**Software:**

**Photoshop 5.5 & After Effects 4.0**
**Adobe Systems Inc.,** 206.675.7000; www.adobe.com.

**Electric Image 2.9**
**Play Inc.,** 916.851.0800; www.play.com.

**VR PanoWorx**
**VR Toolbox**, 407.673.0357; info@vrtoolbox.com; www.vrtoolbox.com.

**Image Lounge**
**Puffin Designs,** 415.331.4560; info@puffindesigns.com; www.puffindesigns.com.

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BY PAUL DAVIES

# A Striking Pose

## MetaCreations Poser 4.0

Poser 4.0 is the latest product in a popular line of 3D software from MetaCreations. What distinguishes Poser from many other popular 3D packages is that it focuses completely on character animation, eschewing modeling and effects. Unlike most 3D animation packages, Poser comes with prebuilt human and animal figures complete with hierarchies and IK setups ready to pose and animate.

Some might argue that this is well within the realm of functionality for Character Studio, the popular plug-in that currently ships with 3D Studio MAX. (Character Studio 2.2 is included on the 3DS MAX CD-ROM, but it must be purchased separately before it can be used.) Closer analysis reveals, however, that only the hierarchical structure is preset in Character Studio. Although tools are provided for attaching a skin (the character's surface geometry), this task is still left for you to accomplish. Poser comes with skinned characters ready to use out of the box, so you can start animating without doing a lick of setup.


**FIGURE 1. Poser 4.0 allows you to mix and match figures and clothing. Sometimes underlying geometry shows through clothing. You can hide any part of a figure to avoid this problem, but that doesn't always work. Here, I couldn't hide Carmen's shirt sleeves because I wanted her cuffs to show.**

**New Features** The main focus in this update is customization. At the top of the list, MetaCreations has added the ability to change clothes on the Poser figures (Figure 1). Once you've familiarized yourself with the process, changing a character's clothes is quite simple. You add the clothes you want to use, and with the click of a button you conform them to your character. Unfortunately, for best results you need to start with a nude figure and add and conform each article of clothing separately. The included clothed figures aren't figures with removable clothes; the mesh is clothes and body morphed together. It would be nice if they were separate, so you could replace specific articles of clothing. You can also now add bendable props. The example given is an elbow pad, but it's never made clear how this differs from clothing.

Poser 4.0 also sports a completely revamped lighting interface that adds intensity control and spotlights. The lights can be controlled by what is now the standard MetaCreations lighting interface, a ball and a bunch of dots (Figure 2). The ball represents your scene and the dots represent lights. When you drag a dot, it orbits the ball and the lighting changes accordingly. It works great for the default Infinite lights. The interface is not so well-suited for spotlights, though. When you drag a dot representing a spotlight, the dot orbits the ball. However, the actual spotlight does not orbit the figure. It simply rotates in place, so the ball doesn't accurately portray the scene's illumination.


**FIGURE 2. The lighting controls. Each dot represents a light in the current scene. The icons below the sphere represent light intensity, light color, light properties, delete light, and create light.**

The ability to create and use morph targets for portions of or whole figures has been added to Poser 4.0, as well as two new deformation tools to help you create morph targets. The deformation tools are somewhat crude compared with the kind of point manipulation available in many of the popular modeling applications. Fortunately, there are loads of morph targets provided with the software (no doubt these are prime contributors to Poser 4.0's large install footprint). There are morph targets for altering figure ethnicity, but unfortunately these do not exist for all figures.

MetaCreations has added a Hierarchy editor and a Grouping tool to help with cus-

tomizing figures. With the Hierarchy editor, you can replace portions of a figure's anatomy with other anatomy pieces or props. The Grouping tool simply allows you to select and group polygons. This is useful for assigning materials.

Aesthetic augmentations have been made to the rendering engine. There are new display styles for the real-time display, including flat shaded with mesh, smooth shaded with mesh, and cartoon style without lines. Unfortunately, these modes are only for real-time interaction and don't render at all. Such tasks are left up to the Sketch Designer, a new rendering tool that makes renders look like hand-drawn images. There are presets for making your renders look like anything from a pastel drawing to a Jackson Pollack painting (well, sort of). You can customize and save your own batch of line settings to affect how the Sketch Designer renders. Also, spherical reflection maps and transparency maps have been added to surface materials to round out the render capabilities.

**Working in Poser** Poser 4.0 has the all the earmarks that I've come to expect from MetaCreations products. It's simple, efficient, intuitive, and pretty (I mean that in the best possible sense). You can figure out a great deal of the functionality without looking at the documentation. Of course, when you do feel the need for a bit of schooling, lots of information is provided in both online and printed formats.

In addition to online help, tool tips are becoming common among many 3D and 2D packages, and Poser is no exception. What is unusual and very refreshing is how Poser handles its hint or tip text. Most packages have a dedicated window or region at the bottom of the interface where all tool tips appear. In Poser, tips or hints appear in the title section of each tool group, allowing you to maintain focus on the area of interest (no need to scan the entire screen).

Poser 4.0 sports a few other handy tools. My favorite tool is Symmetry. Symmetry lets you copy pose properties from one half of a figure's body to the other. There are options for copying an entire side, just the arm, just the leg, or my personal favorite, swapping sides. The ability to swap pose characteristics from one side to the other allows you to mirror an entire pose. This is especially handy for creating walk cycles because you can animate half the cycle, copy all the keys, and flip the poses for each repeated key. Anyone who has animated in a program without this tool will appreciate its value immediately.

Whether you're fresh out of art school or just happen to have thumbed through *How to Draw the Marvel Way* by Stan Lee and John Buscema, if you've had any type of traditional illustration training, you'll be thrilled to know that Poser 4.0 can display head lengths and vanishing lines. Even if you've never heard of these before, they'll come in handy. Vanishing lines are particularly useful for matching your characters' perspectives with photographed or prerendered environments.

I also love the preset cameras, especially the Head and Hand cams. By default, each figure has a camera parented to and pointed at the head, the right hand, and the left hand. These cameras are extremely useful for lip sync and gesture animations. Sure, you could set cameras up to do the same thing in any package with multicamera support, but having them there from the get-go is so much nicer.

Poser has taken a novel approach in its Animation palette. When you select a frame in the editor, neighboring frames along the channel row and frame column are displayed as raised boxes, making it easy to pinpoint your selection (Figure 3). Once you've cre-

## sources

**Poser 4.0** · list price $249
**MetaCreations**
(800) 846-0111
www.metacreations.com ·
**RAPID 3D NO. 151**

**SYSTEM REQUIREMENTS:**
**•Macintosh: PowerMac, OS 8 or greater; 32MB application RAM; CD-ROM drive.**

**•Windows: Pentium, Windows 95/98/NT 4; 32MB system RAM; CD-ROM drive.**

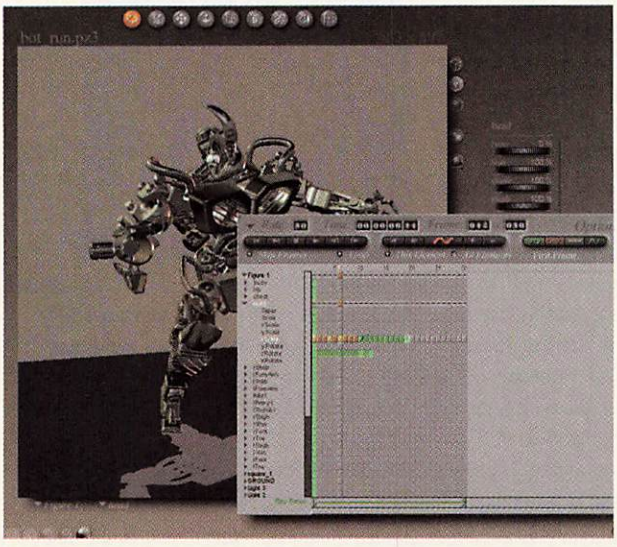

**FIGURE 3. In the Animation palette, it's easy to identify keyframes and curve interpolation types at a glance. Here, the head's Z Scale channel shows five keys with linear interpolation on the first half and spline interpolation on the second.**

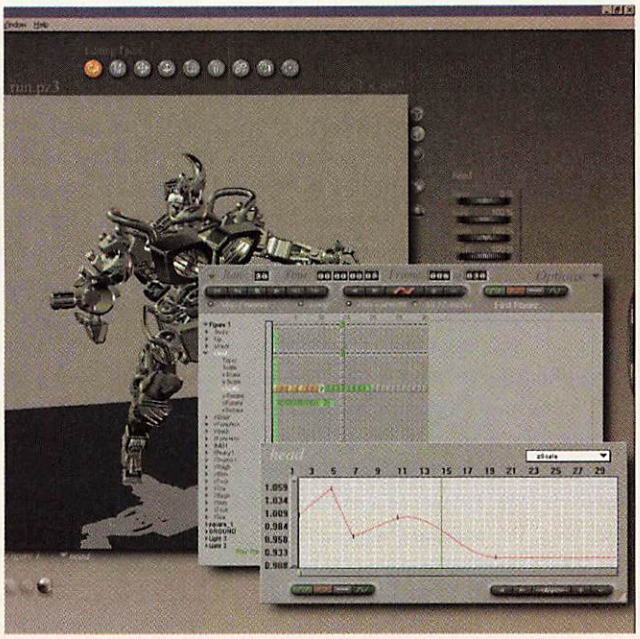

**FIGURE 4. The Z Scale curve in the Graph palette.**

ated two or more keys, you can edit their interpolation in the Graph palette (Figure 4). You can chose between spline, linear, break spline, and constant interpolation types for curves in the Graph palette. Each interpolation type is given a corresponding color in the Animation palette, making it easy to see what's happening in your animation. You can even display sound from imported audio files in the Graph palette. I had only one major complaint about this portion of the application: Although you can move, copy, cut, and paste multiple keys simultaneously in the Animation palette, there seems to be no way to display or edit more than one curve at a time in the Graph palette.

**A Few Gripes** Working in Poser 4.0 is far from a perfect experience. As usual, the clean, seemingly bulletproof Poser user interface belies a horde of nasties.

My first complaint concerns the amount of hard drive space required to store the application. The documentation says 240MB. It actually took 355MB for a so-called minimal install and 363MB for a full install. I originally did a minimal install only to find that some of the textures and props necessary for the tutorials were nowhere to be found. I searched the Application and Content discs to no avail. After completing the full install, the missing files magically appeared on my hard drive.

In the Windows version, the file requesters don't conform to Windows standards. The Cancel button is on the left and the OK button is on the right. It should be the other way around. This may seem trivial—until you accidentally click the wrong button a few times.

**The Rub** All in all, Poser 4.0 is a remarkable program. It does suffer from some classic MetaCreations symptoms, namely erratic behavior and limited compatibility. A former tester at MetaCreations confirmed to me that features sometimes don't work as documented. These aren't fatal errors but flaws; for example, I couldn't make the camera parent—a pretty basic feature—like the tutorial said it would. In terms of compatibility, Poser 4.0's export features are limited and don't include the formats of most popular 3D apps. When creating animations, instead of genrating motion files, Poser 4.0 makes one OBJ file per frame; that was the only way I discovered, which is cumbersome to say the least and rapidly consumes hard drive space.

If you want to animate normal humans and animals and don't want to spend time doing character setup, Poser 4.0 is well worth the investment. This program is also ideal for people just getting started in 3D animation who are looking for a tool to help them strengthen their posing and timing skills. I think of it as "on rails"—it does one thing very well, but it's inherently limited. Dedicated professionals looking for a tool to eliminate setup woes and get their figures up and running (pun intended) should probably keep searching. The additional prep time necessary to get your non-Poser models working properly with Poser 4.0 will probably negate the benefits of using it.

**Paul Davies, formerly of LucasArts, is a principal at Savage Frog!, a character animation studio in San Rafael, CA. You can email him at pablo@savagefrog.com.**


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BY JESSE ANDREWARTHA

# Maya to RenderMan & Back

## Pixar RenderMan Artist Tools 3.2

In the decade since its release, RenderMan has gained a reputation as the premier rendering solution for high-end CG imagery and effects. This legendary software is renowned for top-quality postproduction features such as anti-aliasing, motion blur, and depth of field, as well as a programmable, extensible shader language that provides the degree of flexibility and accuracy necessary for high-volume production. Moreover, RenderMan is designed to manage large models and massive scene files.

During the late '80s, disparities between modeling and rendering systems introduced a need for a standardized interface between them. Consequently, Pixar developed the RenderMan specification, a comprehensive set of rendering API calls that describe objects, scenes, lights, and cameras. Pixar implemented the RenderMan spec as a rendering engine known as Pixar Photorealistic RenderMan (PRMan).

Without any additional software, PRMan presents a procedural user interface, which has been a deterrent to many CG artists. To use any RenderMan-compliant rendering engine, it's necessary to write, compile, and run a program in a conventional programming language, calling RenderMan procedures to describe a scene. Only experienced technical directors and individuals with extensive knowledge of the RenderMan spec, RenderMan shading language, and C/C++ programming were suited for using RenderMan. Thus, a need arose for exporters that would convert the output of 3D apps from their native file formats to RenderMan format, known as .rib (RenderMan Interface Bytestream). However, while this approach provided access to RenderMan from a variety of apps, it didn't enable artists to take full advantage of its capabilities.

To address this situation, Pixar offers RenderMan Artist Tools 3.2, a suite of utilities that augment PRMan (which must be purchased separately). The primary attraction is MtoR (Maya to RenderMan), a plug-in to Alias|Wavefront Maya. Much more than a file format converter, MtoR affords access to the gamut of RenderMan features from within Maya. MtoR not only converts all Maya geometric primitives and lights to RenderMan-compliant versions, it also lets you establish connections between Maya attributes and RenderMan shader parameters. It supports MEL, plus a TCL-based scripting language.

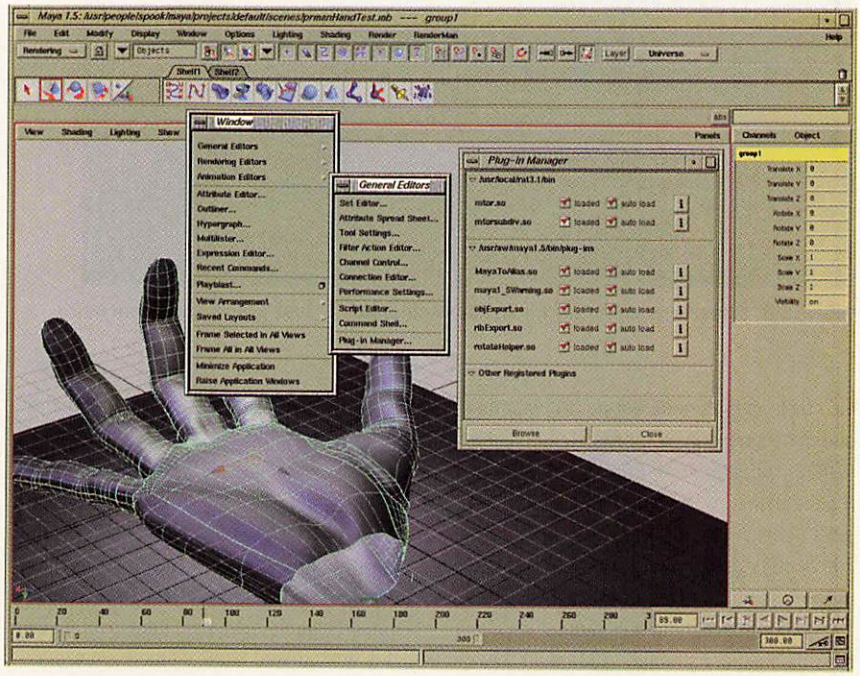


**FIGURE 1. MtoR, the primary component of Pixar RenderMan Artist Tools 3.2, loads into Maya via the plug-in manager.**

In addition to MtoR, RenderMan Artist Tools consists of Alfred (an efficient network renderer) and Combiner (a script-driven compositor) as stand-alone utilities. MtoR provides an interface for Alfred and Combiner when the three are used together. Other components of MtoR are Glimpse (an editor for RenderMan shaders, looks, and appearances) and Pixar Subdivision Surfaces (a polygon-like mesh). All told, these components make a formidable package that allows unprecedented control over the shading and rendering process.

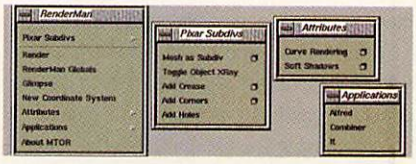


**FIGURE 2. MtoR adds to Maya's menu bar a RenderMan menu that provides access to Glimpse, Alfred, Combiner, and Pixar Subdivision Surfaces, as well as various PRMan controls.**

I tested RenderMan Artist Tools 3.2 (including MtoR 1.1, Alfred 3.1, and Combiner 3.1) with PRMan 3.8 and Maya 1.5 on an SGI O2 R5000 running IRIX 6.5.2. MtoR loads into Maya via the plug-in manager (Figure 1) and adds a RenderMan menu (Figure 2) that provides access to Glimpse (Figure 3), Alfred (Figure 4), Combiner (Figure 5), and Pixar Subdivision Surfaces. Subdivision Surfaces provide a polygon-like mesh that's subdivided upon rendering. The level of subdivision is immense and creates surfaces of

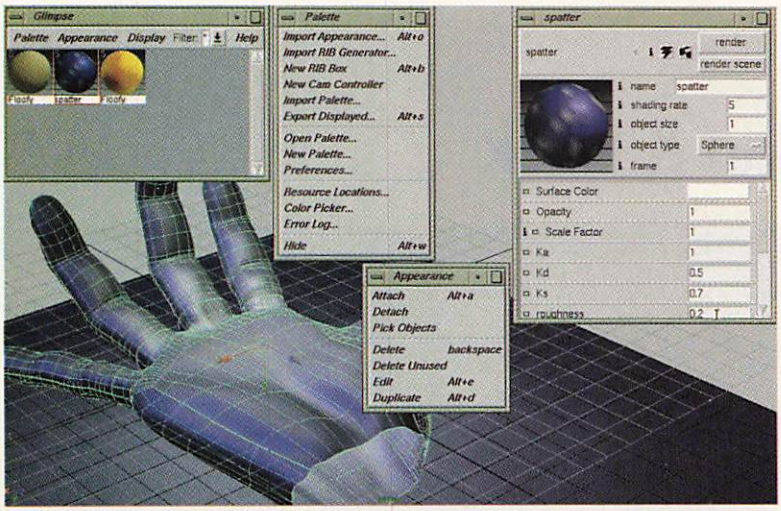


**FIGURE 3. Glimpse is an editor for RenderMan shaders, looks, and appearances.**

incredible smoothness without the seams and consequent CV weighting that plagues NURBS surfaces. Both PRMan and MtoR require paths and environments to be properly established, but this is a simple matter. The documentation and tutorials make it quick to get up and running.

To give RenderMan a workout, I used a NURBS hand constructed in Maya. The hand, which possesses a full skeleton, cradles a particle-based flame. This scene presented a range of challenges to the renderer. The surface consisted of NURBS planes, trims, blend surfaces, and of course particles.

Within a very short time, I was creating RenderMan images (Figure 6). I even used a couple of shaders I had written, originally compiled using Blue Moon Rendering Tools (more about this in moment) and recompiled with PRMan. Shaders assigned by Glimpse can't be interpreted in Maya's textured shading mode, so I had to wait until the final render to check my progress, but the result was amazing. In light of this, it's best to create and test shaders independently and then incorporate them into a scene later. I tweaked the RenderMan Globals to optimize the render settings (Figure 7), and the renderer was incredibly fast with superb image quality.

Even particles normally renderable only through Maya's hardware render buffer can be rendered using RenderMan. Because PRMan provides optimized primitives for particles and curves, MtoR supports many of the common Maya particle modes with software rendering. This makes it possible to use custom shaders that collaborate with MEL expressions, and particles can cast shadows and be anti-aliased.

As powerful as it is, PRMan doesn't raytrace. This is not an oversight. Raytracing requires a renderer to examine a scene as a whole. Without raytracing, PRMan can render small sections of the scene without having to examine the rest. By rendering small sections systematically, immense scene files can be rendered rapidly. Meanwhile, you can use environment and reflection maps to simulate raytraced effects. MtoR automates depth, environment, and reflection mapping while giving you a high degree of control over them.

For those who require the power of RenderMan but are hesitant to forego raytracing, Blue Moon Rendering Tools (BMRT) is a shareware renderer that's compliant with the RenderMan 3.1 spec. It's available for download at www.bmrt.org. Created by Larry Gritz prior to his joining Pixar, BMRT can be used as a stand-alone product; Maya scenes can be exported using RIBexport and run through BMRT for stunning image quality. Better yet, it can be utilized as a rayserver to RenderMan, enabling raytracing in RenderMan images. Shaders must be compiled through both BMRT and the PRMan shading language compilers, as the two compile to different object code formats. When you've established the appropriate UNIX pipe and begun rendering scene files in PRMan, BMRT stands at the ready in the background. When a ray intersects a shader marked for raytracing, PRMan sends a query to BMRT, which returns a value. The result is an image from PRMan with full raytracing where required. This is the method Pixar used to create the all the raytraced motion-picture footage they've produced in their entire history: three

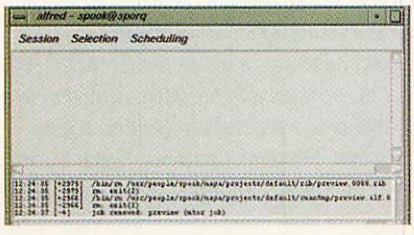


**FIGURE 4. Alfred is the network rendering component of RenderMan Artist Tools.**

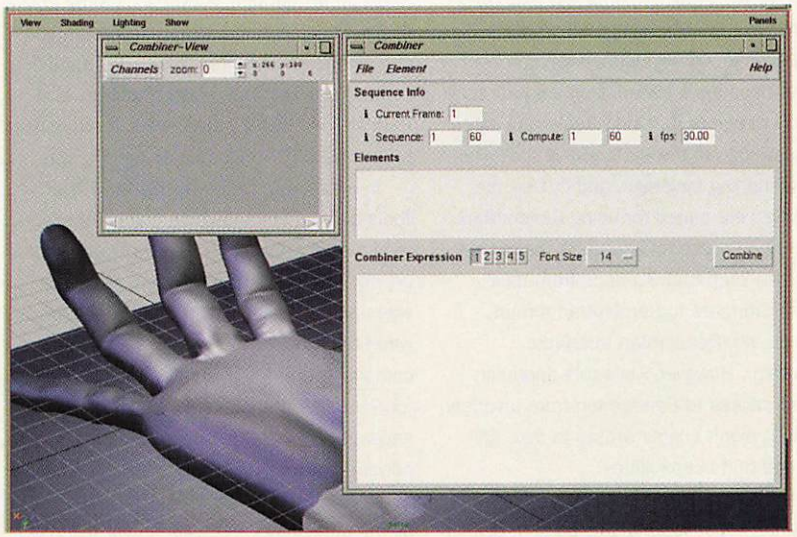


**FIGURE 5. Combiner is a script-driven compositor.**

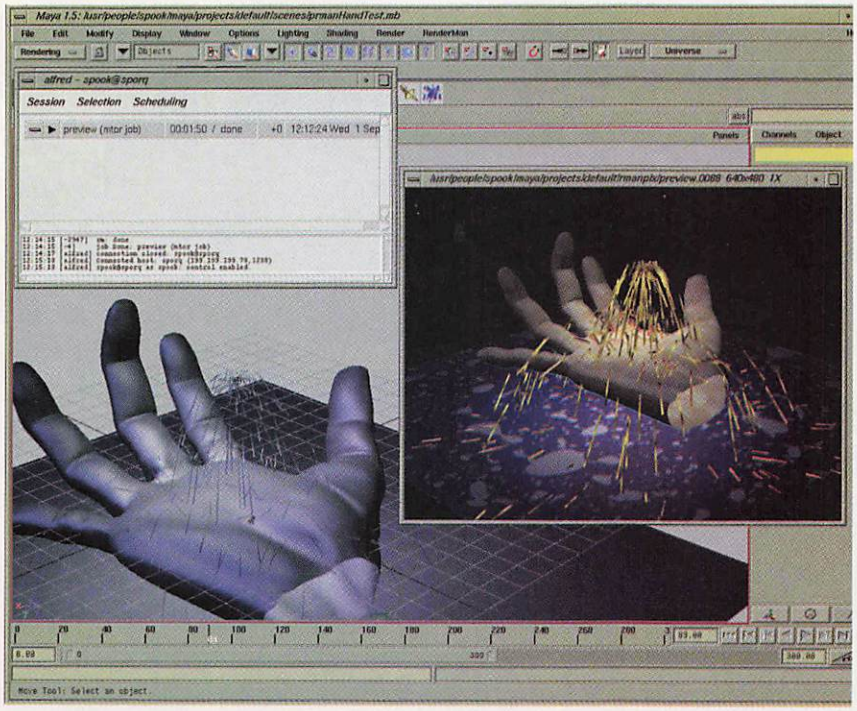

**FIGURE 6. A boned NURBS hand cradling a particle-based flame, constructed in Maya. This scene presented a range of rendering challenges, but MtoR enabled PRMan to handle them quickly and beautifully.**

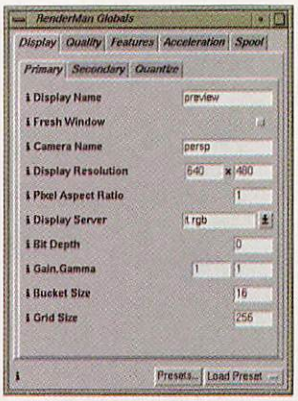

**FIGURE 7. The RenderMan Globals are a set of parameters that let you optimize render speed and quality.**

## sources

**RenderMan Artist Tools 3.2**
4.0 list price $8,500, including Toolkit, MtoR, Alfred, and Combiner)
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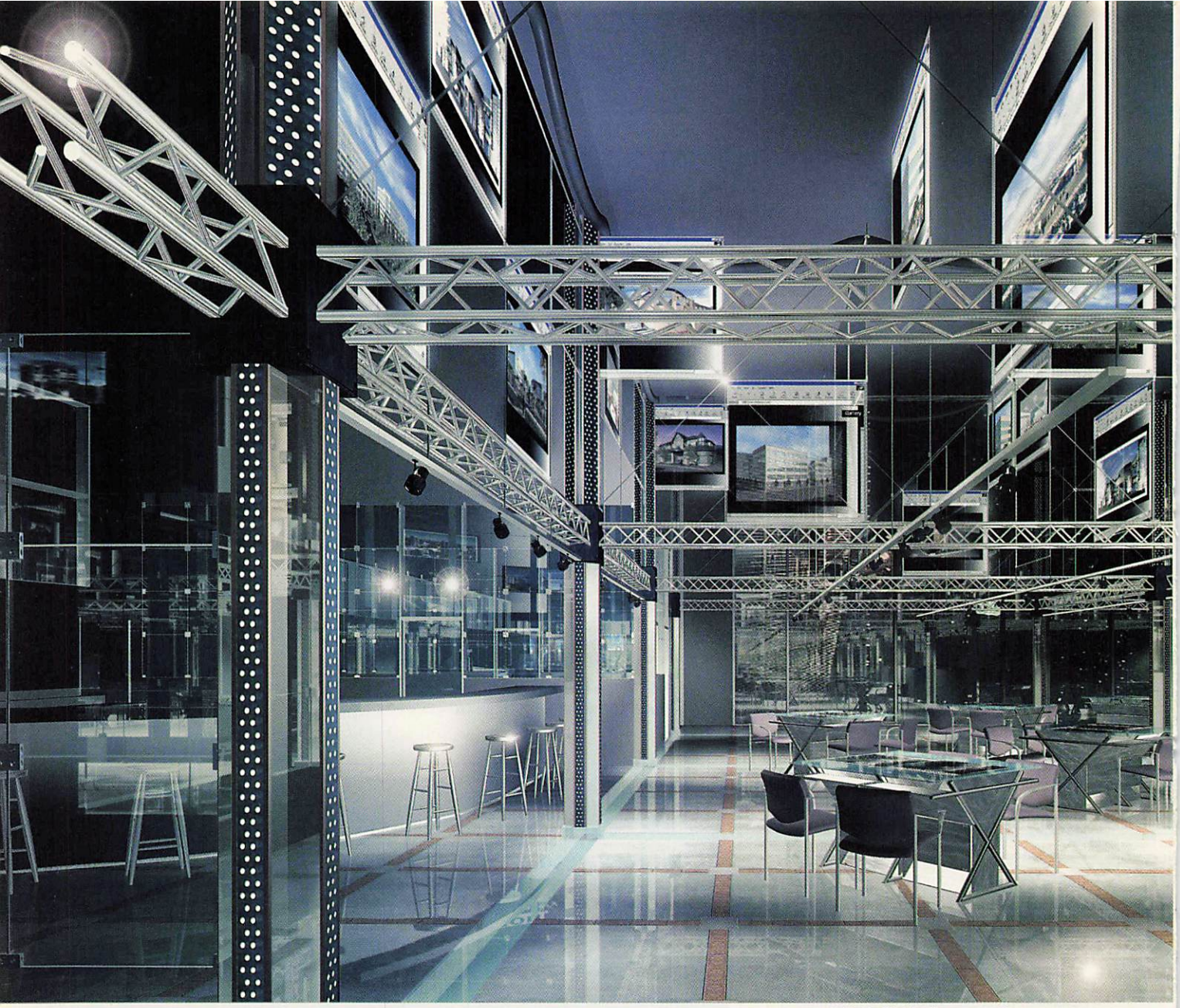
seconds for *A Bug's Life*.

By the time you read this, Pixar expects to have released RenderMan Artist Tools 4.0, concurrently with RenderMan 3.9. The update will add a component known as SLIM that will provide a powerful UI for creating RenderMan shaders, similar to Maya 2.0's Hypershade editor. Like Alfred and the rest, SLIM will be both integrated with MtoR and available as a stand-alone utility, outputting .sl files for RenderMan. Programmers can take heart, however, as writing your own shaders will still be the best way to unlock the power of RenderMan.

When RenderMan was released in 1989, the developer anticipated a flood of RenderMan-compliant renderers. This never happened, but from *Jurassic Park* to *Stuart Little*, RenderMan remains the primary renderer for the CG industry. Giving artists direct control over such a powerful creative tool is the next logical step, and Pixar has done a commendable job with MtoR and RenderMan Artist Tools 3.2.

**Jesse Andrewartha is a technical director at Mind's Eye Media in San Francisco. He also works as an instructor at Mesmer Animation Labs and Ex'pressions Center for New Media in Northern California. You can email him at jesse@mesmer.com.**



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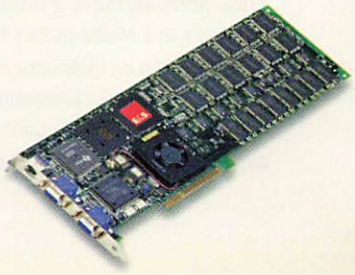

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BY RAF ANZOVIN

# Keyframing Styles of the Rich & Famous

**To control character motion, choose an animation method appropriate to your creative goals.**

**FIGURE 1. This shot from *The Animator's Apprentice* used pose-to-pose keyframing. The pose was designed to communicate expression clearly and easily; quality of in-between movement was a secondary consideration.**

There are as many ways to paint a picture as there are painters. Similarly, there are as many ways to keyframe character animation as there are animators. Most animators are influenced by the technique practiced in a particular studio or by a particular teacher, but almost everyone eventually develops a unique style to match his or her temperament, philosophy, and technical ability. That said, a few widely used approaches form the basis of the way most animators work, and it can be helpful to adopt them as you evolve your own style. In this installment and the next, we'll look at several methods. For now, we'll concentrate on body motion, leaving facial motion for another time.

**Pose-to-Pose** The pose-to-pose technique dates back to the early days of hand-drawn animation, when the Walt Disney studio was inventing the principles of animation from scratch. The two main techniques used were the straight-ahead technique and the pose-to-pose technique. Using the straight-ahead technique, animators created their drawings in numbered sequence from the first to the last. Using the pose-to-pose technique, a lead animator drafted a set of key poses to define important states in the character's motion and allow the director to see the basic movement very quickly. Then, the animator or an assistant drew the in-betweens.

With digital tools, we don't need to draw every frame, but the basic idea of describing the character's actions via a set of important poses and then filling in the motion is still very useful.

The pose-to-pose technique depends on the strength and expressive quality of the character's poses (Figure 1). Cartoonish motion, with its emphasis on extreme poses, is especially well-suited to this technique. The transition period between two poses is de-emphasized; movement has to look good, but the poses tell the story.

Timing the poses is exceedingly important. Very quick movements between poses need to be followed with extended holds that let the pose register with the audience (this is true regardless of the keyframing technique you use, but it's especially important when so much of the acting resides in the poses). Once the key poses have been laid out and you're satisfied with the timing and pose, the transition between the poses is reworked and adjusted until the movement looks snappy. (Most human movements are actually quite quick, although they may look slow to the untrained eye due to the length of time between movements.)

Unfortunately, the way your software interpolates the motion between poses is almost never the kind of movement you really want. Finding the right amount of snap or the right arc between the key poses usually involves either adding keyframes in between or making a lot of adjustments to the f-curves, the graphs that describe motion and rotation over time, for each object.

If the f-curves are allowed to do their natural spline interpolation, most of the time you'll end up with so-called spliney motion. Spliney motion tends to look like it was filmed underwater, with every motion overcompensated as the splines overshoot their control points during a held pose (Figure 2). The way to remedy this is to adjust the control handles of the f-curve control points (Figure 3). Another common technique is to shift certain keyframes a few frames forward or backward after you've created the poses. This technique can be used to create a snap as the extremities reach their key poses slightly after the rest of the body.

Rick May, founder of the CG-Char character animation mailing list (www.cg-char.com), advocates turning off in-between interpolation entirely so the character jumps from pose to pose. (In most programs, this can be accomplished by setting all f-curves from normal spline interpolation to held interpolation.) This can be an effective way of testing the strength of a character's poses. If the shot looks dynamic without in-betweens, it's an indication that the poses are working well and you won't be so tempted to let bad interpolation ruin the shot.

**Layered** In the layered technique, you concentrate on animating each body part separately throughout the animation. Usually, you start by animating the entire body as one piece, figuring out exactly how the pelvis should move. This is the first layer. Once the basic movement has been polished to a shine, you animate the rest of the character in subsequent layers, adding leg motion so it appears to motivate the body, then the arms,

the head, and extremities such as fingers.

The layered technique has its roots in the bad old days of computer animation, when IK, expressions, and constraints didn't exist. The pelvis had to be animated first because, with FK manipulation as the only option, any change to the pelvis movement would throw the legs and arms completely out of whack. We're no longer stuck in FK hell, but animating in layers continues to simplify certain tasks (Figure 4). In particular, the emphasis on polishing the movement of each element in relation to the others makes layered animation a good choice for complex and intricate motion in which the posing and acting of the character is secondary.

The canonical example of this kind of animation is the T-Rex in *Jurassic Park*, animated by Randy Dutra and others at ILM. All the interest in the T-Rex's movement lies in the way she plants her feet on the ground like a heavy animal or the way her neck and spine curl around as she chases the Jeep.

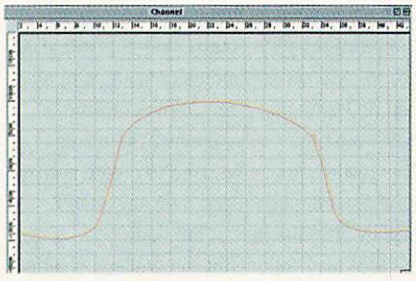

**FIGURE 2. This f-curve—which represents one motion axis of an object as it stays still, moves suddenly, holds, and then moves back—is spliney. The spline overshoots the end point of the motion, which results in an unnatural floating motion when the object is supposedly holding a pose.**

**FIGURE 3. The spliney f-curve has been adjusted to reduce the overshoot when the object stays still. A small amount of overshoot has been left in because a perfectly still pose often looks dead.**

Using the layered technique, creating effective transitions between poses isn't a problem, and the motion looks somewhat more integrated and less stylized.

The drawback is that, while you're concentrating on each layer, it's easy to lose track of the character's overall motion, since the poses aren't revealed until the shot is done. Pose-to-pose motion tends to be very cohesive and reads in a simple and direct manner. With layered motion, there can be a temptation to focus on the subtleties of each particular layer until the character's performance becomes lost in the details.

**Block-and-Fill** Block-and-fill keyframing is similar to pose-to-pose, but uses a layered approach to timing. You work out only the most basic movements to block the overall pacing of the scene quickly. Once the crude timing has been established, you fill in the missing action. Several passes may be required to refine the movement.

This technique is especially useful when the character's performance must match a set of predetermined cues: another character's movement, events in a live-action background, the beat of prerecorded music, and so on. Many animators like working with a system of recursive refinement and sometimes use blocking in place of a pose reel. The recent PDI short, *Fishing*, is a good example of animation created using this technique (see "Angling for Style," November 1999).

**Straight-Ahead** Some animators have repurposed the straight-ahead technique for CG. Obviously, it would be counterproductive to emulate the original technique exactly and adjust the character for every frame. Rather, you keyframe every few frames, starting at the beginning and working through to the end without planning each motion carefully. Only the most important elements are keyframed in the first pass, with the rest added in later passes.

Animators who use this approach claim it gives them a greater sense of spontaneity and pleasantly surprises them with motion they couldn't have planned in advance. The legendary Disney animator Shamus Culhane propounds this technique in his book *Animation from Script to Screen* as the best way to achieve expressive acting in animation. The problem is that unless you, too, are possessed of abundant self-confidence and

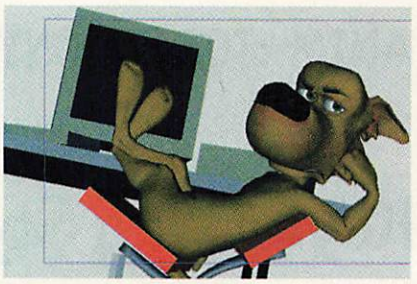

**FIGURE 4. The layered technique was used to animate the chair as it responds to shifts in the character's weight.**

complete control over your art, simply picking the shot up and running with it is more likely to result in incomprehensible garbage then inspired animation.

Even many stop-motion animators don't employ a pure straight-ahead technique. Skellington Studios, the creators of *The Nightmare Before Christmas* and *James and the Giant Peach*, shoots a quick run-through of each scene, changing poses only every five or 10 frames (pretty much the stop-motion equivalent of key poses) before animating the final. A few CG animators employ the straight-ahead technique effectively, but for most, clear planning and careful keyframing almost always results in better performances.

**A Personal Style** Of course, most animators pick and choose aspects of each style to suit their animation goals and then add techniques of their own. I'm primarily interested in creating a strong pose that clearly communicates a character's attitude, so I use mainly the pose-to-pose technique. I also use layering when the animation requires it. The way I like to create the keyframes, however, is somewhat unusual. I prefer to create the motion in small chunks of one or two seconds. I create a few key poses, go back and complete all the motion in between, then continue on to the next chunk. Because I'm a stickler for preplanning with sketches and exposure sheets, I don't worry about losing the shot's general continuity as I concentrate on only a small portion at a time.

Next time, we'll go into detail on how an important acting shot of the blue cat from my project *The Animator's Apprentice* was animated with a pose-to-pose technique. We'll also take a closer look at f-curves and how to control them.

**Raf Anzovin is the co-founder of Anzovin Studio, a character animation house based in Amherst, MA. Contact him at raf@anzovin.com.**

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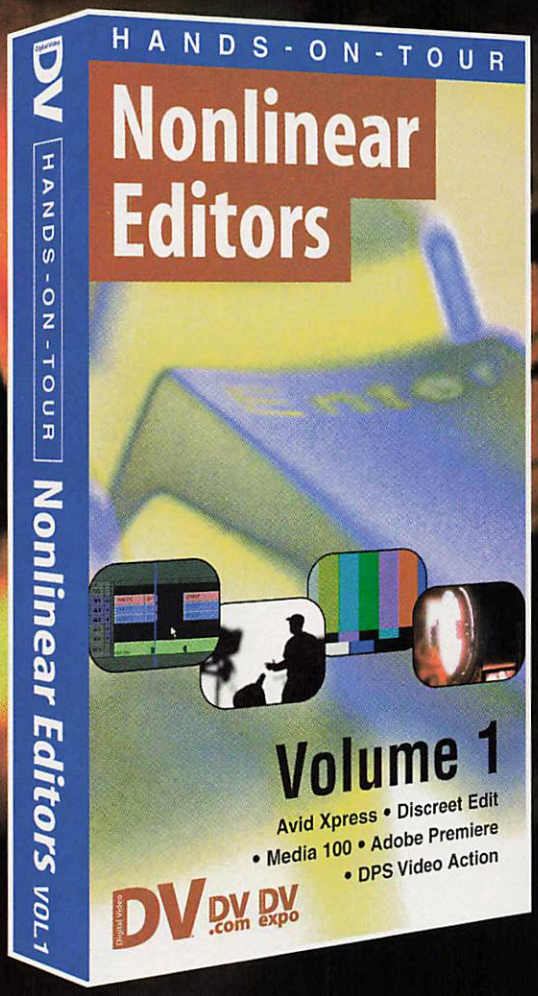


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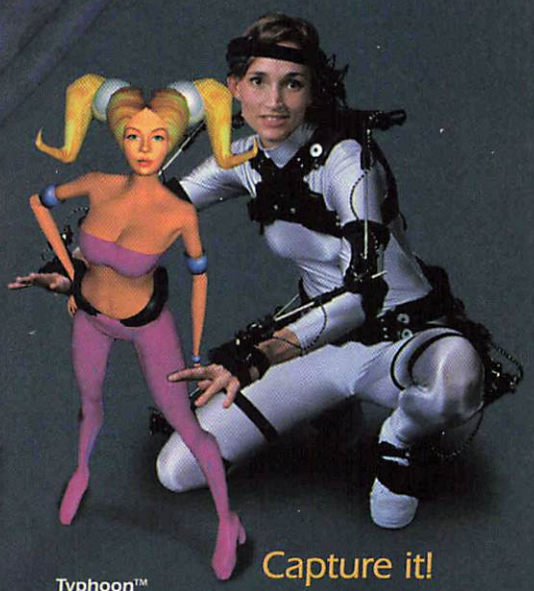
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BY ROB NEDERHORST

# Lean & Mean Texture Mapping

**Keep your textures so trim, you'll never run out of RAM (well, almost).**

Welcome back, brave souls, to the pixel wars. This month, I'd like to talk about optimizing the size of your texture maps. This topic may not seem to be of earth-shattering importance, but in a large-scale production, a little care in this area can save lots of time and storage space without compromising the look of your images. The techniques I'll describe are specific to Adobe Photoshop 5.0, but most of them translate well to 4.0.

The fundamental point is to conserve as much RAM as possible. Why? Because at some point, you're going to run out. Yes, Virginia, even with 512MB of RAM, you'll fill it all at some point and your computer will squeak back at you with a miserable error message.

The amount of RAM a texture map chews up is a function of its resolution. Of course, you want to use the right resolution. But how do you know what's right? It's a big question, I know—but we're only talking about texture maps here, so take a deep breath and button your shirt back up. As a rule of thumb, the resolution of your texture maps doesn't need to be any higher than that of your final rendered image. That is, if you render at D1 video resolution (720x486), your maps don't need to be higher than that. Try to follow this rule for the main maps (color, diffuse, specular, and especially bump).

Lack of resolution in texture maps results in blurry, jagged textures. This is the flaw I see most often in demo reels. It happens when the rendering engine attempts to make up for the lack of resolution by adding lots and lots of anti-aliasing. Figure 1a shows a rendered object with a color map that's too low-res, while 1b shows the same object with a higher-res color map. Similarly, Figure 2a depicts a rendered object with a low-res bump map, while 2b shows the same object with a higher-res bump map.

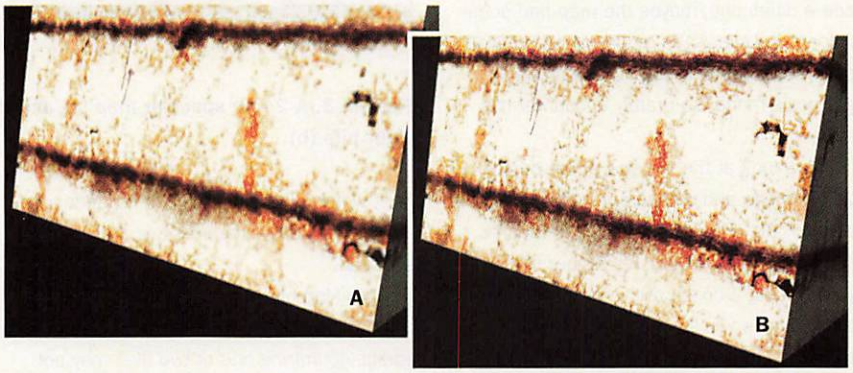


**FIGURE 1. A rendered 3D object with a color map that's too low-res (a) and the same object with a higher-res color map (b).**

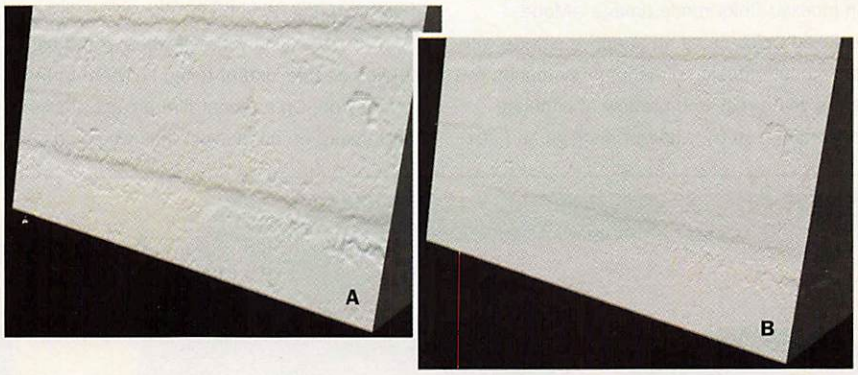


**FIGURE 2. A low-res bump map (a) and the same map in higher resolution (b).**

You can almost taste the difference.

If you keep your maps at a hefty resolution and your output is still plagued with nasty little texture jaggies, feel free to break the rule about maxing out map resolution at the resolution of the rendered output. For TV commercials rendered to D1, I've needed to use maps as high-res as 4000x4000. This usually happens when the texture-mapped object is shown in extreme close-up, but sometimes you just need more detail to show up in the image—detail, as you'll recall from last month's column, is very, very important. Generally, for commercial work, I use 1024x1024 maps, which preserve a bit of extra detail without requiring too much more memory than D1 resolution.

I told you never to use maps whose resolution is lower than the resolution you'll be rendering to, but you can break that rule as well. Those pesky rules are meant to be broken, aren't they? If an object isn't close to the camera, you might be able to cover it with lower-res textures. There aren't any numbers that govern what you can and can't do in this case. Experimentation is necessary to determine what works in each situation.

To reduce memory requirements even further, the next factor to consider is color depth, meaning the number of data bits used to represent colors. In practical terms, color depth boils down to the number of colors in the image. Broadly speaking, specular, diffuse, bump, transparency, translucency, and luminosity maps can be converted to a grayscale color depth (8-bit, 256 colors) since that's the range of grays that exist in our happy CG world. In Photo-

shop, the command sequence is Image→Mode→Grayscale. If we start with the 24-bit specular map depicted in Figure 3a and reduce its color depth in this fashion, the result is Figure 3b. Not much different, is it?

If you try it on one of your own maps and see a difference, maybe the map had some color in it. Unless I'm modifying an original color map, I usually paint those maps in grayscale mode, so I rarely encounter this situation.

Now look at the file size of the original 24-bit image and compare it to the new 8-bit version. Big difference, right? If it doesn't seem like much to you, remember that when you're using a dozen or two or three maps, the kilobytes you save on each one add up to megabytes of memory and hard drive space.

For the ultimate in efficiency, I recommend going to an even lower color depth in Indexed Color mode (Image→Mode→Indexed Color, using an adaptive palette with or without diffusion dithering). Photoshop 5.0 gives you a real-time preview of dithering operations, so try different settings and see what works. Zoom in and look for undesired pixellation. Keep experimenting until you're satisfied.

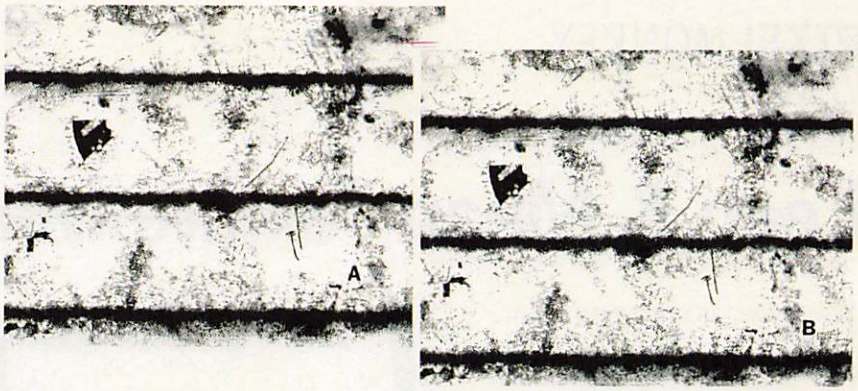


**FIGURE 3. A 24-bit specular map (a) and the same map after reducing color depth to eight bits (b).**

This kind of optimization can extend to color maps as well. As in the situations cited earlier, optimizing one or two files may not save enough RAM to make a difference, but 30 maps later, you'll have saved gobs and gobs of memory, and that will allow you to do more texturing. Woo hoo!

If you're asking yourself whether the big studios do this kind of thing, I'm here to tell you they do. On a recent film project at Digital Domain, we used every trick we could think of to save RAM. The scenes and objects wouldn't load on our machines, even with 512MB of RAM. Using the methods I've described, we were able to reduce the texture overhead of some scenes from 350MB to 75MB. Yes, it works, and it looks great on film. So work with those texture maps until they're as small as they can be without interfering with the look you're after. It may save your skin one day.

**Robert Nederhorst is a pixel coordinator and rendermonkey #3 at Digital Domain. You can contact him at throb@d2.com.**

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Mr. Steve Jobs
Apple Computer Inc.
One Infinite Loop
Cupertino, CA 95014-2084

# Dear Steve...

I call you "Steve" because I think of you as a friend, even though we've only met briefly and exchanged a few words. You are a friend to me in many ways, not the least of which is your commitment to animation and computer graphics through your company Pixar, which produces some of the best stories wrapped in 3D animation ever made. This is not a place for me to drip compliments all over you, though; it's time to get to the heart of the matter.

Enter Apple. Two years ago, the company that you helped to create (for which you were thanked by being fired) was in the final convulsions of what seemed to be its last corporate breath. I, along with many of my peers, prematurely predicted Apple's demise. It looked as if we'd be left with a Windows-only world. In what can only be described as poetic justice, Apple brought you back in by acquiring NeXT, and you immediately set Apple back on a path to profitability with wise business decisions, a focused product line, and renewed commitment to the markets Apple serves so well, mainly graphic design, education, and with the iMac and iBook, the consumer as well.

You've done a phenomenal job, Steve. Apple is healthier than ever, your products are selling well, and professional products like the G4 and Cinema Display are proof that the innovation that brought Apple back from the brink is still job number one. Now, the 3D community needs you to crank it up a notch or two. How? I'm so glad you asked...

First, we don't care that you've made companies like MacAlly and Logitech very happy by crippling users with the iMac keyboard and mouse. Taking a G3 or G4 and putting those peripherals on it is like owning a Ferrari that has a lawn chair for a driver's seat. Unpleasant at best, downright painful at worst. Give us a quality (mouse-shaped) mouse and a full-sized keyboard. It's part of what we're paying for, and we ain't gettin' it.

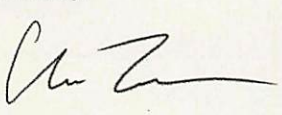
Next, work more closely with third-party vendors, especially the graphics card companies. Although fine for consumers and some professional 2D work, the ATI Rage is a joke when it comes to high-end 3D. The amazing power of the G3s and G4s is being stymied by a graphics card that is generations old. Whether you OEM it from another company, help a third party to deliver it, or make it yourself in the garage, fix this problem. A lot of artists would use the Mac for 3D if it could handle the graphics that NT workstations can.

Get OS X out, and make sure it works. Going up against Microsoft in any way is often seen as suicidal, and going up against Windows itself even worse, but it looks like you have a winner on your hands with OS X. Please don't screw it up. Give us a stable and powerful GUI, preemptive multitasking, and a UNIX shell, and I'll be one happy camper who uses Windows a heck of a lot less. Many companies in the content creation space are adopting an "anything but Windows" stance, and Linux isn't quite ready for prime-time, so your window of opportunity is now.

Last but not least, buy Alias|Wavefront. Pixar has already announced their partnership with A|W and the fact that they are using Maya Unlimited, so the winds may already be blowing in that direction. Many people I have contacted about this said they'd dump Wintel altogether, if only Maya ran on a Mac. Buy the company (or just the Maya part), port it to OS X, and you will have a platform, operating system, and software support that would have 3D designers drooling with lust and getting out their wallets for a major upgrade.

That said, Steve, I wish you and Apple the best for the future. Your vision and insight have ensured (thus far) that 3D artists and digital content creators have an attractive alternative to the Wintel world, and I would encourage any artists who haven't used the new Macintoshes to Think Different and take one for a test drive. You'll never look at Windows quite the same way again.

Sincerely,



Chris Tome
Technical editor, *3D* magazine

**Chris Tome is technical editor for *3D* magazine and wrote this on a G3 PowerBook 400. He's currently hiding from Keri, Apple's loan pool manager, but you can still reach him at ctome@mfi.com. Unless you're Keri, then he's out.**

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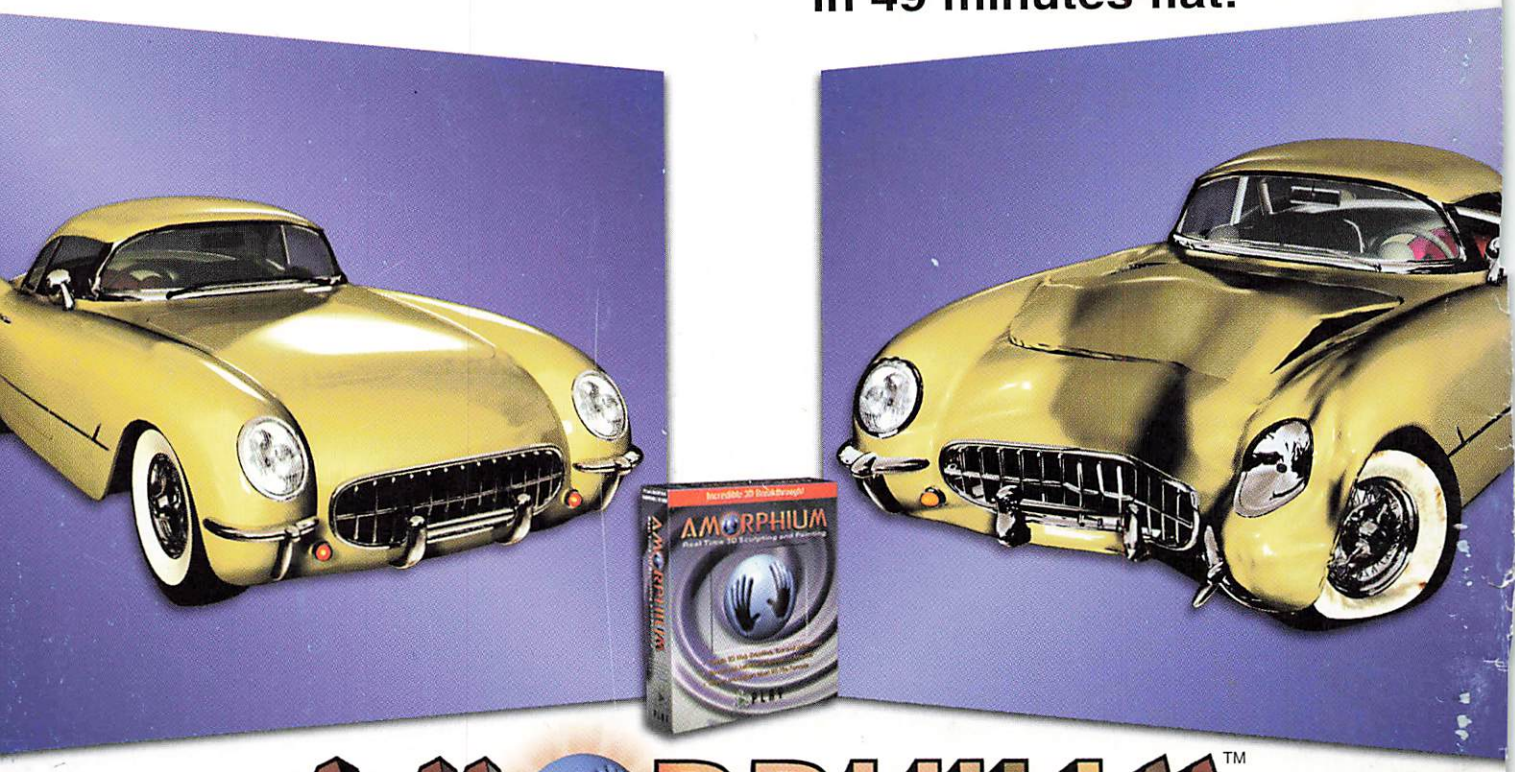


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